plain vaultings of the middle ages is, that all the curves are segments of circles, the diagonals being struck from a centre below the springing of the lateral and cross ribs, and are contrasted in this respect with diagonals projected from the direct arches, according to the rule familiar to every carpenter, from which it results that all the points of a groined vault coincide, and will be touched by a straight line drawn from one end of such a range of vaulting to the other. To this mode of setting out the curves may be attributed the flagrant want of character which is apt to distinguish the modern imitations of Gothic vaulting, and it may even be observed in original examples, that the effect is less pleasing as this coincidence is more nearly approached. This is the case with vaultings executed after the four-centered arch came into fashion, in which, although the curves may not be projected, yet there is an approach to greater regularity from the springing of all the ribs being brought to one level. During the Norman period the drawing of the vaults is very rude, and we find it to have been frequently necessary to back up the extrados of the ribs in order to bring the spandrils into shape. In the succeeding period of our architecture more care was indispensable, on account of the greater complication of mouldings converging together at the springing, and the free and sketchy manner in which they are managed, and the superfluous mouldings got rid of before they overload the impost, is much to be admired, and is greatly superior to the method pursued in the 15th century, when the coverging ribs were all brought down to the impost, and died away into a mere bundle of reeds, of which the effect is exceedingly tame and uncharacteristic. Previously to the introduction of the last style of gothic vaulting, *fan groining*, various complicated figures were formed by the introduction of numerous cross ribs, but the mode of construction continued to be the same. The vaulting immediately preceding fan groining, which may, in fact, be considered as a transition style, Professor Willis designated as *stellar* groining, from the star shapes which usually enter into its composition, and it is remarkable, that in some cases this form is lost in execution, although laid down on the plan, the architect apparently not having calculated on the effect of perspective, whereas, in others, the artist has evidently depended upon it in order to bring out his design. At length, in fan groining, the compartments become so numerous that the system of separate ribs is abandoned, and the vaults are constructed according to the ancient and modern principle of cut stone. Professor Willis accompanied his lecture by an extensive display of drawings and models, illustrative of the geometrical system upon which he supposed the Gothic architects to have worked in producing these results.

After the lecture the noble President presented to Mr. Hall the medal of the Institute, which had been awarded for his essay on iron roofs.

July 19.—R. WALLACE, Esq., in the Chair.

Henry Gally Knight, Esq., was elected an honorary member.

Mr. Hall's essay on iron roofs, to which the medal of the Institute had been awarded, was read.

This was the closing meeting of the session.

CALOTYPE.

THE following account of some recent improvements in photography, by H. F. Talbot, Esq., was lately read before the Royal Society.

The author had originally intended, in giving an account of his recent experiments in photography, to have entered into numerous details with respect to the phenomena observed; but finding that to follow out this plan would occupy a considerable time, he has thought that it would be best to put the Society, in the first place, in possession of the principal facts, and by so doing perhaps invite new observers into the field during the present favourable season for making experiments. He has, therefore, confined himself at present to a description of the improved photographic method, to which he has given the name of *Calotype*, and reserves for another occasion all remarks on the theory of the process. The following is the method of obtaining the Calotype pictures.

Preparation of the Paper.—Take a sheet of the best writing paper, having a smooth surface and a close and even texture. The watermark, if any, should be cut off, lest it should injure the appearance of the picture. Dissolve 100 grains of crystallized nitrate of silver in six ounces of distilled water. Wash the paper with this solution, with a soft brush, on one side, and put a mark on that side whereby to know it again. Dry the paper cautiously at a distant fire, or else let it dry spontaneously in a dark room. When dry, or nearly so, dip it into a solution of iodide of potassium containing 500 grains of that salt dissolved in one pint of water, and let it stay two or three minutes in this solution. Then dip it into a vessel of water, dry it lightly with blotting-paper, and finish drying it at a fire, which will not injure it even if held pretty near; or else it may be left to dry spontaneously. All this is best done in the evening by candle-light. The paper so far prepared the author calls *iodized paper*, because it has a uniform pale yellow coating of iodide of silver. It is scarcely sensitive to light, but, nevertheless, it ought to be kept in a portfolio or a drawer, until wanted for use. It may be kept for any length of time without spoiling or undergoing any change, if protected from the light. This is the first part of the preparation of Calotype paper, and may be performed at any time. The remaining part is best deferred until shortly before the paper is wanted for use. When that time is arrived, take a sheet of the iodized paper and wash it with a liquid prepared in the following manner:—Dissolve 100 grains of crystallized nitrate of silver in two ounces of distilled water; add to this solution one-sixth of its volume of strong acetic acid. Let this mixture be called A. Make a saturated solution of crystallized gallic acid in cold distilled water. The quantity dissolved is very small. Call this solution B. When a sheet of paper is wanted for use, mix together the liquids A and B in equal volumes, but only mix a small quantity of them at a time, because the mixture does not keep long without spoiling. I shall call this mixture the *gallo-nitrate of silver*. Then take a sheet of iodized paper and wash it over with this gallo-nitrate of silver, with a soft brush, taking care to wash it on the side which has been previously marked. This operation should be performed by candle-light. Let the paper rest half a minute, and then dip it into water. Then dry it lightly with blotting-paper, and finally dry it cautiously at a fire, holding it at a considerable distance therefrom. When dry, the paper is fit for use. The author has named the paper thus prepared *calotype paper*, on account of its great utility in obtaining the pictures of objects with the camera obscura. If this paper be kept in a press it will often retain its qualities in perfection for three months or more, being ready for use at any moment; but this is not uniformly the case, and the author therefore recommends that it should be used in a few hours after it has been prepared. If it is used immediately, the last drying may be dispensed with, and the paper may be used moist. Instead of employing a solution of crystallized gallic acid for the liquid B, the tincture of galls diluted with water may be used, but he does not think the results are altogether so satisfactory.

Use of the Paper.—The Calotype paper is sensitive to light in an extraordinary degree, which transcends a hundred times or more that of any kind of photographic paper hitherto described. This may be made manifest by the following experiment:—Take a piece of this paper, and having covered half of it, expose the other half to daylight for the space of *one second* in dark cloudy weather in winter. This brief moment suffices to produce a strong impression upon the paper. But the impression is latent and invisible, and its existence would not be suspected by any one who was not forewarned of it by previous experiments. The method of causing the impression to become visible is extremely simple. It consists in washing the paper once more with the gallo-nitrate of silver prepared in the way above described, and then warming it gently before the fire. In a few seconds the part of the paper upon which the light has acted begins to darken, and finally grows entirely black, while the other part of the paper retains its whiteness. Even a weaker impression than this may be brought out by repeating the wash of gallo-nitrate of silver, and again warming the paper. On the other hand, a stronger impression does not require the warming of the paper, for a wash of the gallo-nitrate suffices to make it visible, without heat, in the course of a minute or two. A very remarkable proof of the sensitiveness of the calotype paper is afforded by the fact stated by the author, that it will take an impression from simple moonlight, not concentrated by a lens. If a leaf is laid upon a sheet of the paper, an image of it may be obtained in this way in from a quarter to half an hour. This paper being possessed of so high a degree of sensitiveness, is therefore well suited to receive images in the camera obscura. If the aperture of the object-lens is one inch, and the focal length fifteen inches, the author finds that *one minute* is amply sufficient in summer to impress a strong image upon the paper of any building upon which the sun is shining. When the aperture amounts to one-third of the focal length, and the object is very white, as a plaster bust, &c., it appears to him that *one second* is sufficient to obtain a pretty good image of it. The images thus received upon the Calotype paper are for the most part invisible impressions. They may be made visible by the process already related, namely, by washing them with the gallo-nitrate of silver, and then warming the paper. When the paper is quite blank, as is generally the case, it is a highly curious and beautiful phenomenon to see the spontaneous commencement of the picture, first tracing out the stronger outlines, and then gradually filling up all the numerous and complicated details. The artist should watch the picture as it developes itself, and when in his judgment it has attained the greatest degree of strength and clearness, he should stop further progress by washing it with the fixing liquid.

The fixing process.—To fix the picture, it should be first washed with water, then lightly dried with blotting paper, and then washed with a solution of bromide of potassium, containing 100 grains of that salt dissolved in eight or ten ounces of water. After a minute or two it should be again dipped in water and then finally dried. The picture is in this manner very strongly fixed, and with this great advantage, that it remains transparent, and that, therefore, there is no difficulty in obtaining a copy from it. The calotype picture is a negative one, in which the lights of nature are represented by shades; but the copies are positive, having the lights conformable to nature. They also represent the objects in their natural position with respect to right and left. The copies may be made upon Calotype paper in a very short time, the invisible impressions being brought out in the way already described. But the author prefers to make the copies upon photographic paper prepared in the way which he originally described in a memoir read to the Royal Society in February 1839, and which is made by washing the best writing paper, first with a weak solution of common salt, and next with a solution of nitrate of silver. Although it takes a much longer time to obtain a copy upon this paper, yet, when obtained, the tints appear more harmonious and pleasing to the eye; it requires in general from three minutes to thirty minutes of sunshine, according to circumstances, to obtain a good copy on this sort of photographic paper. The copy should be washed

and dried, and the fixing process (which may be deferred to a subsequent day) is the same as that already mentioned. The copies are made by placing the picture upon the photographic paper, with a board below and a sheet of glass above, and pressing the papers into close contact by means of screws or otherwise. After a calotype picture has furnished several copies, it sometimes grows faint, and no more good copies can then be made from it. But these pictures possess the beautiful and extraordinary property of being susceptible of revival. In order to revive them and restore their original appearance, it is only necessary to wash them again by candle-light with gallo-nitrate of silver, and warm them; this causes all the shades of the picture to darken greatly, while the white parts remain unaffected. The shaded parts of the picture thus acquire an opacity which gives a renewed spirit and life to the copies, of which a second series may now be taken, extending often to a very considerable number. In reviving the picture it sometimes happens that various details make their appearance which had not before been seen, having been latent all the time, yet nevertheless not destroyed by their long exposure to sunshine. The author terminates these observations by stating a few experiments calculated to render the mode of action of the sensitive paper more familiar. 1. Wash a piece of the iodized paper with the gallo-nitrate; expose it to daylight for a second or two, and then withdraw it. The paper will soon begin to darken spontaneously, and will grow quite black. 2. The same as before, but let the paper be warmed. The blackening will be more rapid in consequence of the warmth. 3. Put a large drop of the gallo-nitrate on one part of the paper, and moisten another part of it more sparingly, then leave it exposed to a very faint daylight; it will be found that the lesser quantity produces the greater effect in darkening the paper; and in general, it will be seen that the most rapid darkening takes place at the moment when the paper becomes nearly dry; also, if only a portion of the paper is moistened, it will be observed that the edges or boundaries of the moistened part are more acted on by light than any other part of the surface. 4. If the paper, after being moistened with the gallo-nitrate, is washed with water and dried, a slight exposure to daylight no longer suffices to produce so much discoloration; indeed it often produces none at all. But by subsequently washing it again with the gallo-nitrate and warming it, the same degree of discoloration is developed as in the other case (experiments 1 and 2). The dry paper appears, therefore, to be equal, or superior in sensitiveness to the moist; only with this difference, that it receives a virtual instead of an actual impression from the light, which it requires a subsequent process to develope.

PLASTER ORNAMENTS.—The late Mr. Bernasconi was engaged, we believe, to a greater extent than any other ornamental plasterer of the present century, under all the leading architects of the day. We were lately induced to pay a visit to his former scene of business, in Alfred Street, Tottenham Court Road, now in possession of Mr. Brown, his son-in-law, who has lately arranged the numerous ornaments bequeathed him by the late possessor. They are well deserving of a visit by the architect; here he will find Grecian, Roman, Gothic, Elizabethan, the Renaissance, Arabesque, and almost every other style of ornaments that have been introduced at Windsor Castle, Buckingham Palace, Pavilion Brighton, Stafford House, Westminster Abbey, Fonthill, Woburn Abbey, York Minster, Ely Cathedral, and numerous other public buildings and mansions throughout the United Kingdom.

MISCELLANEA.

WESTMINSTER BRIDGE.

On Thursday, 15th ult., the water was admitted into the coffre-dam inclosing the 15th and 16th piers, and the next day a commencement was made in removing the clay preparatory to drawing the piles. It is intended to open two arches for navigation before any further steps are taken with the next dam, which is to enclose one pier only. A deep water channel is now in progress of being made on the north side of the river, in line with the two arches about to be opened, by a steam dredging engine, for the use of navigation. The present neglected state of the river not only interferes most injuriously with the interests of those who navigate it, but causes the velocity of the current at the latter part of the ebb to be greater than is consistent with safety to the number of small boats and inexperienced persons frequenting the river at this season of the year. It is, therefore, a consummation much to be desired, that a subject so important to the welfare of this great metropolis should receive the attention it deserves, and that the city authorities, aided by government, will yet be able to carry into effect either their former scheme of embanking the river to a more regular line, or some modification of this plan by which the present evils may be removed, so that this noble river may again be restored to its former usefulness.

OPENINGS OF RAILWAYS.

The thirtieth of June witnessed a great extension of the Great Western Railway, as on that day the main line was opened from Chippenham to Bath, 13 miles, the Cheltenham and Great Western to Cirencester, and the Bristol and Exeter from Bristol to Bridgewater, 33 miles. Thus the Great Western Railway is opened throughout 118¼ miles, and there is a continuous line of railway communication from London to Bridgewater of 152 miles in length.

On the 5th of July 28¼ miles of the Brighton line were opened, being from the Croydon Junction to Hayward's Heath, and 5 miles from Clayton Tunnel to Brighton, a measure which augurs well for the successful opening of the remainder.

The extension of the Blackwall railway to Fenchurch Street was to take place about the period of our publication, so that all the metropolitan railways would thus be complete at their London termini.

The unfortunate accident to the Fareham tunnel on the Gosport branch of the South Western Railway, has unfortunately delayed the opening of that line, just when it was on the point of being examined by the Government inspector.

GREENWICH RAILWAY.

Amounts of the tenders delivered on the 6th ult. for the fourth contract for widening the Greenwich Railway from the Croydon Junction.

Messrs. Lee	15.825
Mr. Munday	15.990
Messrs. Little	16,189
Mr. Grimsdell	16.536
Messrs. Ward	16,698
Mr. Bennett	16,920
Messrs. Piper	16.920
„ Grissell & Peto	17.280
„ Baker	17,440

THE "PRINCESS ROYAL" STEAMER.

This splendid vessel, which appears to surpass the speed of any other in the north, is now running between Liverpool and Glasgow, and has made several successful trips; she performed a trip from Dublin to Liverpool in 9 hours, and another trip on the 9th ult. from Greenock to Liverpool in 15½ hours, the quickest passage on record, the distance is 227¾ miles; she carried at the time 100 tons actual weight. Both the vessel and engines were built by Messrs. Tod & Macgregor of the Clyde Foundry, Glasgow, the former is of the following dimensions, viz., 185 feet keel and 208 feet on deck, 28 feet beam, and 17 feet hold above the flooring, draws when light 8 feet, and when full 10 feet of water; her register is 750 tons (N.M.). She is entirely built of iron, (there is not a single beam of wood,) very strong, and has a fine appearance in the water, her cabins are very richly and tastefully fitted up. The vessel is propelled by two steeple or upright engines of 190 horse power *each*, or 380 together; the power is applied direct to the crank. Diameter of cylinders is 73 inches, length of stroke 6 ft. 3 in., performs 18 strokes per minute when in good trim, and 17 strokes with from 100 to 120 tons of cargo, diameter of paddle-wheel over floats 29 feet length of float 7 ft. 9 in., and breadth 28 inches, speed in still water 15 miles per hour.

Launch of the Devastation War Steam-vessel.—The launch of this first-class war steam-vessel took place at Woolwich, on Saturday, 3rd ult. Mr. Lang, master shipwright, superintended the launch; she was immediately after hauled into the dock, opposite the blacksmith's workshop, where she will be coppered, and will be afterwards taken into the basin to have her engines fitted and made ready for sea. The Devastation is about 180 feet long, and about 1,050 tons burden, old measurement, or about 1,000 tons burden according to the new mode of calculation.

The Cadogan Chain Pier, Chelsea.—Earl Cadogan, the lord of the manor, has erected a handsome and convenient pier for steam-boat passengers on a novel construction, at an expense of between £3,000 and £4,000. This erection was constructed by Mr. Cubitt, from the design and under the direction of Mr. Handford, the surveyor and architect of the manor. The pier is situated in the mall of Cheyne-walk, the most beautiful part of Chelsea, and forms one of the most interesting objects of the place. Shortly the pier will be open to the public.

Professor Wagner's Electro-Magnetic Engine.—The German journals publish the following extract from a protocol drawn up by the Germanic Diet:—"The Germanic confederation desiring to acquire, for the purpose of publishing for the public good, the secret by means of which citizen Philip Wagner, of Frankfort, makes use of electro-magnetism as a moving force, will secure to the said Wagner for the exclusive possession of his secret the sum of 100,000 florins (£8,000 British), on condition that he cause an electro-magnetic machine to be constructed at his own expense, and upon a sufficiently large scale, to serve as a locomotive; that a trial be made of this machine, in order that the diet be assured of its efficacy; and that M. Wagner consented to abide by the decision of the Diet on that trial. The Diet will wait for one month for M. Wagner to accept those conditions.

Land-slip at Sidmouth.—A land-slip of considerable extent took place at Sidmouth on the 11th ult., about seven in the evening. It commenced about half-past six by a rumbling noise, resembling a distant peal of thunder, and at seven o'clock part of the Peak Hill was observed to glide towards the ocean, carrying everything before it, and forming a rock or pillar out of the sea (70 feet high and 175 feet in circumference), opposite to the town, and a quarter of a mile from the shore. It is covered with fossils, and is of a hard iron-like substance. So singular an occurrence has attracted the attention of every one in the town, and hundreds are flocking from the immediate neighbourhood to gain a sight of its results.—*Dorset Chronicle.*

The Dissolving Views at the Royal Polytechnic Institution.—The directors of this scientific institution, ever seeking to combine amusement with instruction, have recently added to their numerous attractions an entirely new series of

dissolving views by Messrs. Wrench & Smith, which, for selection of subjects and the artistic feeling with which they are treated, may be considered unquestionably the best of the kind hitherto exhibited; there are sixteen in number, and if we may judge from the gratification evinced by the numerous company who attend upon each occasion that these beautiful views are shown, the spirited proprietors cannot but congratulate themselves upon having secured such to an exhibition, which is and must doubtless become an increasing attraction to this institution.

LIST OF NEW PATENTS.

GRANTED IN ENGLAND FROM 28TH JUNE, TO 28TH JULY, 1841.

Six Months allowed for Enrolment.

JOHN CHATER, of the Town of Nottingham, machine-maker, and RICHARD GRAY, of the same place, lace manufacturer, for "*improvements in machinery for the purpose of making lace and other fabrics, traversed, looped, or woven.*"—Sealed June 26.

WILLOUGHBY METHLEY and THOMAS CHARLES METHLEY, of Frith-street, Soho, ironmongers, for "*improvements in machinery for raising, lowering, and moving bodies or weights.*" (A communication.)—June 26.

MOSES POOLE, of Lincoln's-inn, gentleman, for "*improvements in producing and applying heat.*" (A communication.)—June 26.

WILLIAM LOSH, of Little Benton, Northumberland, Esq., for "*improvements in the manufacture of railway wheels.*"—June 26.

NATHANIEL BENJAMIN, of Camberwell, gentleman, for "*improvements in the manufacture of type.*" (A communication.)—June 28.

WILLIAM KNIGHT, of Durham-street, Strand, gentleman, for "*an indicator for registering the number of passengers using an omnibus or other passenger vehicles.*"—June 28.

CHRISTOPHER NICKELS, of York-road, Lambeth, gentleman, for "*improvements in the manufacture of mattresses, cushions, paddings or stuffings; and in carpets, rugs, or other napped fabrics.*"—June 28.

WILLIAM THOMAS BERGER, of Upper Homerton, gentleman, for "*improvements in the manufacture of starch.*"—June 28.

THOMAS MARCHELL, of Soho-square, surgeon, for "*improvements in raising and conveying water and other fluids.*"—June 28.

GEORGE HENRY PHIPPS, of Deptford, engineer, for "*improvements in the construction of wheels for railway and other carriages.*"—July 2.

THOMAS HAGEN, of Kensington, brewer, for "*an improved bagatelle board.*"—July 7.

GEORGE ONIONS, of High-street, Shoreditch, engineer, for "*improved wheels and rails for railroad purposes.*"—July 7.

ROBERT MALLET, of Dublin, engineer, for "*certain improvements in protecting cast and wrought iron and steel, and other metals, from corrosion and oxidation; and in preventing the fouling of iron ships, or ships sheathed with iron, or other ships or iron buoys, in fresh or sea water.*"—July 7.

WILLIAM EDWARD NEWTON, of Chancery-lane, civil engineer, for "*certain improvements in the manufacture of fuel.*" (A communication.)—July 7.

THOMAS FULLER, of Bath, coachmaker, for "*certain improvements in retarding the progress of carriages under certain circumstances.*"—July 7.

ANDREW M'NAB, of Paisley, North Britain, engineer, for "*an improvement or improvements in the making or construction of meters or apparatus for measuring water or other fluids.*"—July 7.

CHARLES WHEATSTONE, of Conduit-street, gentleman, for "*improvements in producing, regulating, and applying electric currents.*"—July 7.

JOHN STEWARD, of Wolverhampton, Esq., for "*certain improvements in the construction of piano fortes.*"—July 7.

THOMAS YOUNG, of Queen-street, London, merchant, for "*improvements in lamps.*"—July 9.

CHARLES PAYNE, of South Lambeth, chemist, for "*improvements in preserving vegetable matters where metallic and earthy solutions are employed.*" July 9.

WILLIAM HENRY PHILLIPS, of Manchester-street, Manchester-square, civil engineer; and DAVID HIGGINBOTHAM, of the same place, gentleman, for "*certain improvements in the construction of the chimneys, flues, and air tubes, with the stoves, and other apparatus connected therewith, for the purpose of preventing the escape of smoke into apartments, and for warming and ventilating buildings.*"—July 13.

BENJAMIN BEALE, of East Greenwich, engineer, for "*certain improvements in engines, to be worked by steam, water, gas, or vapours.*"—July 13.

MOSES POOLE, of Lincoln's-inn, gentleman, for "*improvements of steam baths, and other baths.*" (A communication.)—July 13.

MILES BERRY, of Chancery-lane, civil engineer, for "*improvements in the construction of locks, latches, or such kind of fastenings for doors and gates, and other purposes to which they may be applicable.*" (A communication.)—July 14.

THOMAS PECKSTON, of Arundel-street, Strand, Bachelor of Arts, and PHILIP LE CAPELAIN, of the same place, coppersmith, for "*certain improvements in meters for measuring gas, and other aeriform fluids.*"—July 15.

ANDREW SMITH, of Belper, Derby, engineer, for "*certain improvements in the arrangement and construction of engines, to be worked by the force of steam, or other fluids; which improved engines are also applicable to the raising of water and other liquids.*"—July 21.

JOHN M'BRIDE, manager of the Nursery Spinning Mills, Hutchisontown, Glasgow, for "*certain improvements in the machinery and apparatus for dressing and weaving cotton, silk, flax, wool, and other fibrous substances.*"—July 21; four months.

JOHN WHITE WELCH, of Austin-Friars, merchant, for "*an improved reverberatory furnace to be used in the smelting of copper ore, or other ores which are or may be smelted in reverberatory furnaces.*"—July 21.

FREDERICK THEODORE PHILIPPI, of Belfield-hall, calico-printer, for "*certain improvements in the production of sal ammoniac, and in the purification of gas for illuminations.*" (A communication.)—July 21.

WILLIAM WARD ANDREWS, of Wolverhampton, ironmonger, for "*an improved coffee pot.*"—July 21.

WILLIAM NEWTON, of Chancery-lane, civil engineer, for "*certain improvements in machinery for making pins and pin nails.*" (A communication.)—July 28.

ANTHONY BERNHARD VON RATHEN, of Kingston-upon-Hull, engineer, for "*improvements in high-pressure and other steam-boilers, combined with a new mode or principle of supplying them with water.*"—July 28.

ANTHONY BERNHARD VON RATHEN, of Kingston-upon-Hull, engineer, for "*a new method or methods* (called by the inventor, 'The United Stationary and Locomotive System') *of propelling locomotive carriages on railroads and common roads, and vessels on rivers and canals, by the application of a power produced or obtained by means of machinery and apparatus unconnected with the carriages and vessels to be propelled.*"—July 28.

ERRATA.

SIR—In my communication on "*Slopes in Sidelong Ground,*" in this month's (July) Journal, page 220, you will find the following misprints, which you will perhaps have the kindness to notice in your next publication.

For $(w \tan \beta - F\,L) = C\,F$, read $(w \tan \beta + h) = C\,F$.

$$\text{For } C\,D = (w \tan \beta + h)\,\frac{\sin C\,F\,D}{\sin C\,E\,F}, \text{ read } C\,D = (w \tan \beta + h)\,\frac{\sin C\,F\,D.}{\sin C\,D\,F}$$

$$\text{For } C\,E = (w \tan \beta + h)\,\frac{\sin C\,F\,D}{\sin C\,D\,F}, \text{ read } C\,E = (w \tan \beta + h)\,\frac{\sin C\,F\,D}{\sin C\,E\,F}.$$

For "therefore the angle C *D* F will be constant," read "therefore the angle C *F* D will be constant."

W. R.

In the review of Windsor Castle the following errors of the reviewer were passed unobserved until after the article had gone to press.

Page 278, col. 2, for Edward *the Third* called the Confessor, read Edward *the Confessor*.

In the 2nd paragraph, for Henry *III* read Henry *I*.

Page 279, col. 1, 3 lines from the bottom, for Henry 7 read Sir Reginald Bray. And in the last line, for *his* read *Henry VII*.

TO CORRESPONDENTS.

Mr. Barrett's *and* Mr. Brooks' *communications must stand over until next month; also the communications from* S. L. *and* D. C. *We must beg of our correspondents to excuse us in postponing any articles of controversy.*

"A clear fire." *In our opinion his scheme is not practicable.*

"On the forms and proportions of steam vessels," *was received as we were going to press; it will appear next month.*

Two communications on long and short connecting rods are in type, but must stand over until next month for want of space.

Communications are requested to be addressed to "The Editor of the Civil Engineer, and Architect's Journal," *No. 11, Parliament Street, Westminster.*

Books for Review must be sent early in the month, communications on or before the 20th (if with drawings, earlier), and advertisements on or before the 25th instant.

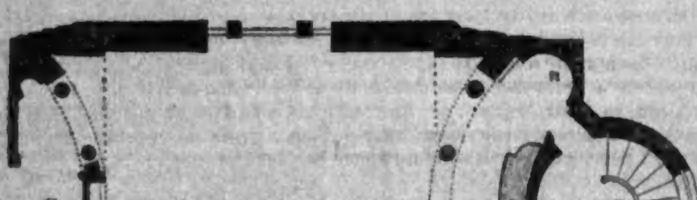
Vols. I, II, and III, may be had, bound in cloth, price £1 each Volume.

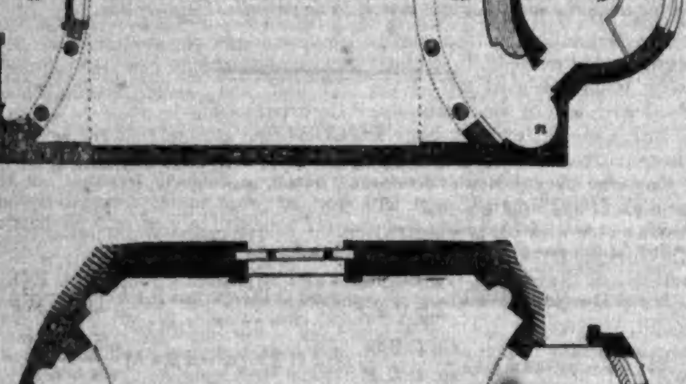
EPISODES OF PLAN.

(Continued from page 143.)

We should be less embarrassed by the extent and complexity of our subject, could we command an unlimited number of cuts to illustrate it; but being under the necessity of observing economy in that respect, and to confine ourselves to *floor-plans* alone, without attempting to show anything further, we experience no little difficulty in determining what sketches to give in preference, out of the ample stock of our materials. Under such circumstances it will perhaps be expected that we should select such as bear the least resemblance to each other; yet, by so doing, we could not show how the same leading idea may, by some slight modification of it, be so altered as to produce a room of quite different character. Which last consideration induces us to give a second plan for a dining-room, bearing a strong resemblance to the preceding one in its general shape and arrangement, yet greatly varied from it with respect to many other circumstances. Therefore, in order that the two may be more conveniently compared together, we will here again introduce the first one, which was but indifferently printed when originally given.

Fig. 1.



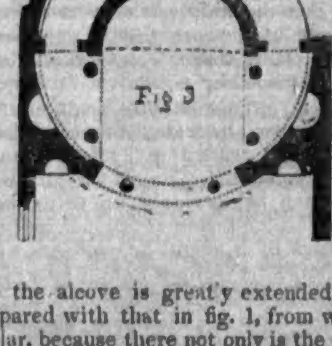


Owing to the peculiarity or singularity of both these ideas, the resemblance between them will probably be thought far more striking than the difference, since the second one also shows a room whose ends are convex in plan, and which is otherwise very similarly arranged. The situation here given to the fire-place would be in itself too trifling a variation to call for notice, were it not that it materially alters the character of the whole, by leaving the entrance recess entirely open to the room; and in consequence, the elevation of that end becomes precisely similar to the opposite one, each of them presenting three open intercolumns, formed in this instance merely by a distyle in antis, consequently with two columns less than in the other plan. A more important distinction is that in this second plan the corners of the room are cut off, whereby not only is the somewhat objectionable sharpness of the angles, occasioned in the other instance by the curved ends being brought up to the side walls, avoided, but the proportion which the end elevation bears to the entire breadth of the apartment is also altered. Besides which, four niches, placed diagonally on the plan, are thus obtained, where they would seem to come in with great propriety—conspicuously, but not obtrusively; on the contrary, where they are in some measure required in order to fill up, and give importance to those spaces. For the last assigned reason, niches are likewise introduced into the entrance recess A.

Should it be made an objection that in consequence of its forming two intersecting curves in its plan, the part A would either occasion much space to be lost, or render it difficult to connect this apartment with an adjoining one, it may be got over by converting the curved wall in which the door is placed into a flat one. Such alteration would still leave the rest of the design just the same as before; nevertheless its character would in some degree be affected by it, and that for the worse, if only because the uniformity now kept up, by the smaller recess A being curved both ways similarly to the larger one B, would then be destroyed. How far the circumstance here noticed would create difficulty by interfering too much with the general plan of the house, must depend upon what would be altogether foreign from our present purpose to take into consideration; our object here being merely to suggest new ideas, and bring forward episodical portions of a plan, not to adapt them to plans in general. We leave the particular application of them to others, leaving also those who may care to adopt any of our hints to adapt and modify them accordingly as circumstances may require; for what would be found eligible and convenient enough in one case, would prove exactly the contraryin another A remark to the same effect has, we find, already been made by us, nevertheless it is one that will very well bear to be repeated, as it is likely to be forgotten by others, though it is highly important that it should be constantly borne in mind by our readers.

The sideboard alcove B does not call for much explanation or comment, we shall therefore confine ourselves to saying that the same accommodation is here afforded as in the first plan, namely an entrance into it for servants. Though two doors are shown, one of them would be sufficient for the purpose, and the other might either be a sham one, or should the plan allow of its being done, might be made to lead to a strong closet for containing the more valuable articles of plate, and also a small retiring closet, &c. The window in this alcove is supposed to be at a considerable height from the floor—eight or nine feet—as the sideboard would be placed beneath it; and it is intended merely to obtain some light from a back court or area, for which reason it should have coloured or ground glass, but merely of such hue as would be sufficient to correct rawness of effect, and throw a sunshiny glow into that end of the room. Though it is differently represented in the cut (fig. 2), it would perhaps be better to confine this window to what now forms its centre compartment (corresponding in breadth with the centre intercolumn of the alcove), treating it as an oblong transparent panel, slightly sunk in the upper part of the wall.

We will now submit another idea professing to be no more than a variation of the alcove capable of being adapted to either of the preceding plans; for which reason it is unnecessary to show the whole of the room in the cut.



In this instance the alcove is greatly extended as to depth, more especially as compared with that in fig. 1, from which, indeed, it is altogether dissimilar, because there not only is the recess considerably shallower, but its back wall is curved convexly, and concentrically with the elevation towards the room. At the same time it resembles fig. 1, in so far as it occupies the entire width of the room; but then again, such resemblance is attended with a very material difference, inasmuch as in fig. 3, the alcove is more enclosed, so that it seems to expand itself within, as viewed through the external columns. The same may be said of it, if it be compared with fig. 2, that being a simple recess merely divided off from the room by columns, and no wider within than its opening towards the room.

Fig. 3, on the contrary, affords an example of what may very well be distinguished by the name of a *compound* recess,—and also of what

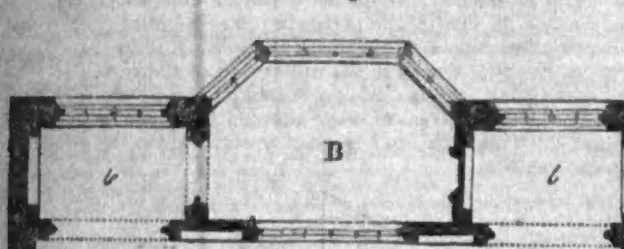
many will, no doubt, be apt to consider a strangely fanciful—not to say fantastical, arrangement. We certainly cannot produce authority for any thing of the kind, because we do not recollect, and therefore may safely affirm that we have never met with any similar instance. If others choose to say, it ought on that very account, to be received with a good deal of suspicion, they are certainly at liberty to do so—or for that matter, to reject our ideas and opinions altogether.

Capricious as it may at first sight be considered, this alcove (fig. 3), will, we think be found, on examination, to be well motived and commodious in plan. While the inner columns would produce great richness of effect—would render the whole a striking architectural picture; they serve also to define the central space, to keep that part more distinct from the rest, thereby giving more importance to that, and by screening off the spaces behind them, to convey the idea of the alcove's being greatly extended by the addition of these last. Nor is it in such respect alone that the plan belongs to the class we would distinguish as compound, since such character is still further increased by the addition it receives from the part *s*, which is here made to form a second or inner recess where the sideboard would be placed, and which therefore should be allowed to show itself distinctly as such by being treated as a large niche, or else covered with a semidome carried up above the ceiling of the alcove and room. In the last mentioned case, that recess might be lighted from above through its dome, nor would other light be then required; should that however, not be practicable, and should an arched niche-like recess also be objected to for the design, it would then be better to contract the space *s*, reducing it from a semicircle to a more shallow recess whose curvature would be *anti-concentric* to, and therefore correspond with, that on which the columns facing it are placed,—as is done in the recess B, fig. 2.

Almost any one of these three plans above will be found, if studied for that purpose, to contain within itself the germs of many others; and notwithstanding that they possess something in common—taking them altogether they furnish more variety, as far as plan is concerned, than is now to be met with in as many thousand examples,—which however they may differ as to matters of decoration and detail are nearly alike in regard to arrangement and plan.*

Instead of proceeding, as we could easily do, with other plans of the same class, and for similar purposes, we will, by way of change, now exhibit one for the window side of a library, occupied entirely by three bays. In order both to obtain novelty of character, and increase picturesque

Fig. 4.



effect, the larger bay B, in the middle, is converted into a sort of case separated from the rest of the rooms, by an open screen with tracery, and carried down to about three feet from the floor. This screen, which might either be glazed or not, as should seem most expedient, would not only be characteristic and ornamental in itself, but be rather serviceable than otherwise, by moderating the light within the body of the room, and thereby rendering the two open bays, *b b*, more piquant and brilliant by contrast. In fact the plan would admit of the lower part of the screen being closed up to the height of about six feet from the floor, by which means additional space for book-shelves, on one if not both sides of it, might be obtained. And although this would materially diminish the light in that part of the room, little if any inconvenience would result from that circumstance, because it is here supposed that the room itself is chiefly intended to contain books, and that the cabinet B, and the two bays *b b*, would be for sitting in. Accordingly the fire-place is put within B, as the most convenient situation; and as that one would be sufficient, the space that must otherwise be occupied by a chimney-piece and chimney pier would be left free for book-cases or shelfing.

With the same plan, a room of very different appearance as to design, if not exactly as to character, might be produced by merely transposing the situation of the enclosed and open portions,—that is by removing the screen between B and the room, and in lieu of it, screening off the two lesser bays *b b*, which might either immediately communicate with, and be open towards the larger bay, or entirely shut up from it, as one of them is shown in the cut. In the former case a vista would be obtained through the three bays, by a compartment at each end filled with a mirror, so as to give the effect of an open arch; or else instead of being filled with a single mirror, each of those compartments might be divided into panels by mullions, &c., like those of the screens, whereby the effect of an additional open screen in each of the smaller bays, might be obtained.

As our chief object is rather to afford suggestive hints, than to give plans definitively fixed, and intended for some one individual case, we do not pretend to enter into more exact description. The cut itself too, must likewise be received as a mere explanatory sketch, it being on too small a scale to admit of nicety as to detail, or do more than indicate the arrangement and principal forms.

(To be continued.)

* Should this be disputed, we should feel obliged to any one who would inform us what remarkable instances of the kind there are which would tend to support an opinion contrary to that here expressed.—ED.

ON THE CONSTRUCTION OF OBLIQUE ARCHES.

SIR—I am sorry to trespass again on your pages in reference to Mr. Peter Nicholson's work on Railway Masonry, but having a few days since been made aware that a second edition of his book was published, in which a reference was made to some remarks I had previously written in your Journal, I procured a copy of it, and the reference in question being nothing more or less than a gross misrepresentation of facts, I trust you will allow me space to set the matter in its proper light.

The point in dispute is relative to Mr. Nicholson's trihedral system. In his first edition he says at page xxiii, "If a trihedral be cut by a plane perpendicular to one of its oblique edges, the section shall be a right angled triangle." Relative to this I made the remark that there were three sorts of trihedrals, and that this assumption only holds good with one of them, namely, a right trihedral.

In his second edition, page xxix. A, after stating that the trihedral there treated is a right trihedral, he says, "if *such* a trihedral be cut by a plane perpendicular to one of its oblique edges, the section shall be a right angled triangle." To the end of which he appends the following complimentary observation. "I have called this kind of trihedral a right trihedral; but a narrow-minded hireling, who signs himself W. H. B., in the Civil Engineer and Architect's Journal, page 152, has erroneously transcribed from a paragraph following, Def. 6, page xxiii., Railway Masonry, first edition, 'If a trihedral be cut by a plane perpendicular to one of its oblique edges, the section shall be a right angled triangle,' leaving out the part that would make sense. His remarks, founded on this mistranscription, resemble rather the puerilities of childhood, than the reasoning of mature age."

Setting aside his personal abuse which will neither benefit his position nor injure mine, the reply I have to make to the rest of his observation is, firstly, that in saying I have mis-quoted his work, he deliberately states that which he knows to be untrue; and there stands the paragraph at page xxiii., of the first edition to prove it.

Secondly. In saying I omitted the part that made sense of the passage, he accuses me of the very blunder he himself committed, of which the fact of his having corrected himself at page xxix. A, of the present edition, is abundant evidence.

The fact is, the page (xxix. A) is a fresh page which he has added to his book, for the express purpose of inserting the corrected paragraph; and has attached my remark to the corrected paragraph, declaring it to be a misquotation. It is really very lamentable to see a man of the standing Peter Nicholson once had, obliged to have recourse to so mean and unworthy a subterfuge; and it is still more lamentable to see him forget himself so much in the language he makes use of. I consider it to be the duty of every one who is in a position to do so, to expose the errors of a work addressed to the public; particularly when it comes from the pen of one who has enjoyed a considerable portion of their confidence and support, and is addressed to those classes who being unable to investigate the subjects contained in it for themselves, are compelled to rely implicitly on what is given to them by the author. With this view I made my remarks on Mr. Nicholson's first edition, and with this view I now proceed to show that a great deal yet requires alteration in the second.

Taking for example page 7, he says, "in order to prevent two joints from meeting each other, it is necessary that the number of arch stones in each face should be an odd number." Now every body at all ac-

Fig. 1.

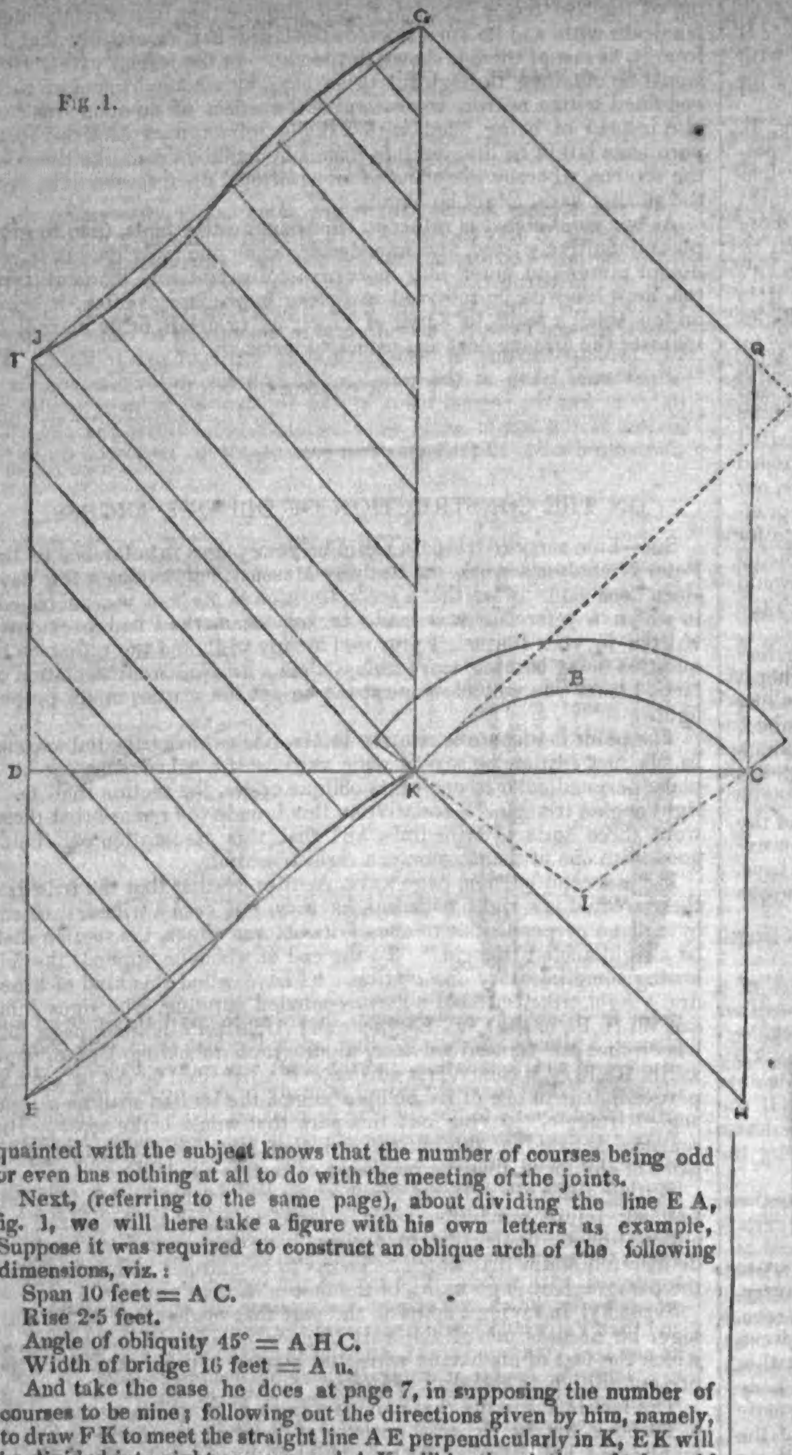


Fig. 3.

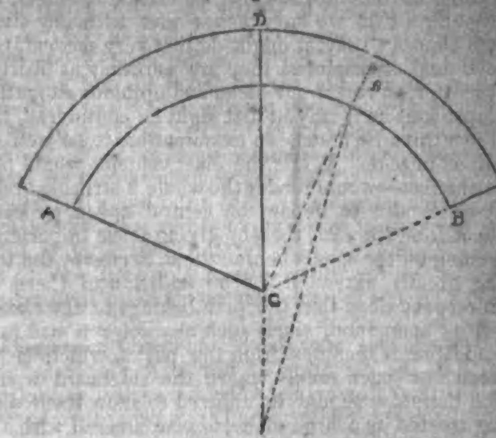
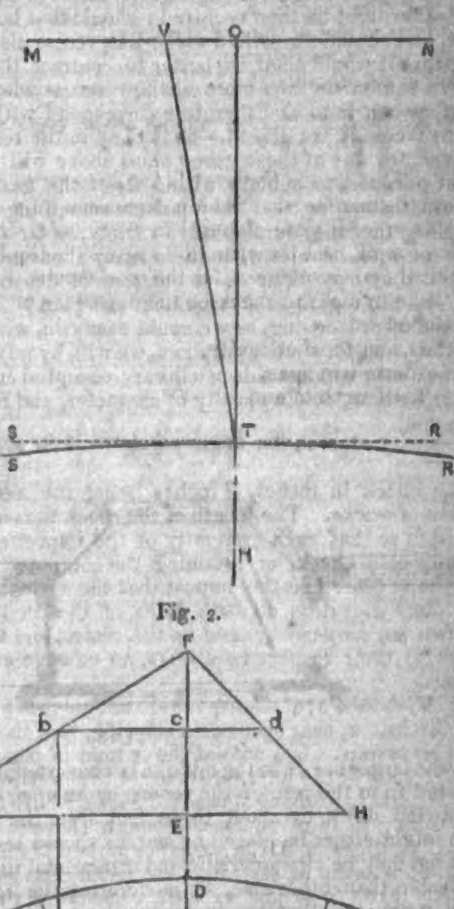


Fig. 4.



quainted with the subject knows that the number of courses being odd or even has nothing at all to do with the meeting of the joints.

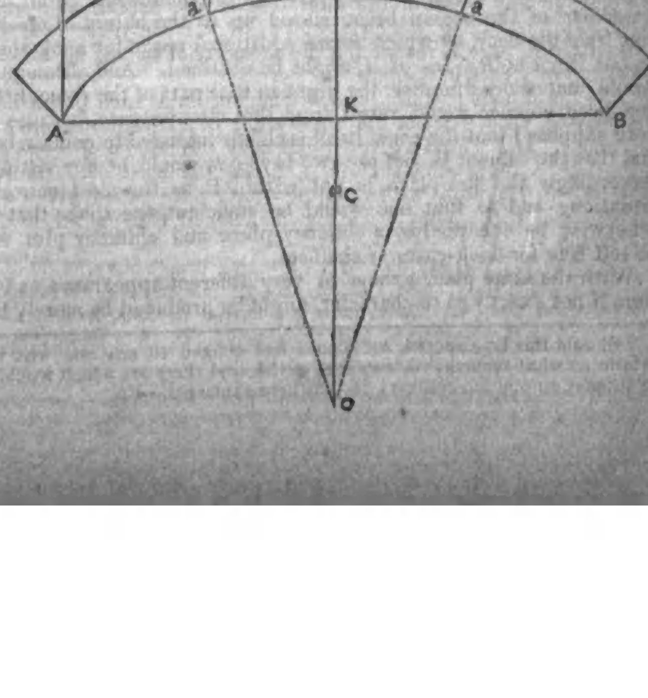
Next, (referring to the same page), about dividing the line E A, fig. 1, we will here take a figure with his own letters as example. Suppose it was required to construct an oblique arch of the following dimensions, viz.:

Span 10 feet = A C.
Rise 2·5 feet.
Angle of obliquity 45° = A H C.
Width of bridge 16 feet = A u.

And take the case he does at page 7, in supposing the number of courses to be nine; following out the directions given by him, namely, to draw F K to meet the straight line A E perpendicularly in K, E K will be divided into eight courses, and A K will be the ninth; *which would require eight courses to be 1 foot 10·17 inches thick, and the remaining one to be 6·36 inches thick.* Now I would ask, does Mr. Nicholson really come forward with such a rule as this, and call his book a *Guide to Railway Masonry?* Is he ignorant of the fact that Mr. Buck has surmounted this difficulty by the simple expedient of adjusting the angle of intrado—or is it that, rather than acknowledge his inferiority, he persists in what he knows to be wrong, and addresses his book to the working classes in the hope of escaping detection?

Again, with reference to obtaining the angles between the joint lines in the face and in the soffit of the arch. It is perfectly distressing to see a problem which admits of easy solution so miserably mutilated as it is in his hands. The construction given by him, that is to say the only one that deserves the name of an approximation, occupies two and a half closely printed pages of his book, while these angles may be obtained with much greater accuracy, and with about a quarter of the labour as follows. Let A D B fig. 2 be the elliptical face of

Fig. 2.



the arch, and O the point to which the joints in the face converge (see Buck on Oblique Bridges); produce O D to F any convenient distance, and make F E = half the obliquity of the arch. Draw G H parallel to A B, set off G E = A K, join G F, and draw the line F H, making the angle E F H equal the angle of extrado.

Then to find the curved bevel for any joint a, join $a\ o$, and draw $a\ b$ and $b\ d$ respectively parallel to O F and G H. Take two lines $m\ n$, $o\ h$, at right angles to each other, as at fig. 3, set off $o\ v = d\ c$, fig. 2, and from v, with a distance equal to $a\ o$, fig. 2, describe an arc intersecting $o\ h$ at t. Then applying the mould of curvature of the spiral line of the intrado $s\ t\ r$, so that the line $s'\ t\ r'$ drawn at right angles to $o\ h$, is a tangent to the curve at the point t; the angles $s\ t\ v$ and $r\ t\ v$, are the bevels adapted for the joint a, fig. 2, and the corresponding joint a' on the other side of the arch. With this construction the angles for all the joints may be obtained from fig. 2, without any confusion in the figure.

These angles may also be obtained by computation, for let A D B, fig. 4, be the elevation of the arch on a plane at right angles to the axis of the cylinder, and C be its centre, and let a the position of any joint be given. The angle D C a being then known,

If the angle D C $a = \lambda$,
Angle of obliquity of arch $= \theta$,
Angle of extrado $= \varphi$,
And the radius of the cylinder $= r$.
Let r (cot. θ, sec. φ) $= a$,
And r (cot. θ, tan. φ) $= b$,

*Then $\frac{a\ (\sin.\ \lambda)}{(b\ \cos.\ \lambda) + r}$ = tangent of the angle $v\ t\ o$ fig. 3.

An oblique bridge however is not necessarily built of stone, nor has it always stone faces. Yet Mr. Nicholson would have the same interminable process gone through in every case, while if the arch be entirely of brick, and the span, the angle of obliquity, and the radius are given, all that is required for the workmen is the angle of skew-back, and the length of the check on the impost, which are at once obtained as follows:

Let θ = angle of obliquity,
s = square span,
a = length of arc,

$\frac{(\cot.\ \theta)}{a}\ s = \tan.\ \beta$, the angle of skew-back, and $(\mathrm{cosec.}\ \beta)\ 3 =$ length of the check in inches, 3 inches being the assumed thickness of a course of bricks. The length of the check thus obtained may be either adjusted so that each extremity of the impost coincides with the extremity of a check, or retaining the computed length of check, they may be so placed on the impost that the springing shall take place at the same elevation on both sides of the arch. After which if the courses are properly gauged on the centre, and the course lines drawn down to their respective checks, no mistake can arise in laying the bricks.

Mr. Nicholson's rules however are not only very unnecessarily tedious, but it would appear by his own showing, that they are not over certain in their results. In a note at the bottom of page 22, in reference to a model made by the joint assistance of two masons, a joiner, and Nicholson's Guide to Railway Masonry, he says, "N.B. the model here alluded to has only 16 spiral courses, although 17 were intended. However, the calculations in all the principal parts will remain the same." One course too many in sixteen is not much certainly, but in these economising times it is just as well, considering that it is just as easy to know before hand how many courses there are to be in a bridge. In whatever way however the alteration of the number of courses was produced, one thing is clearly showed by it, namely, the fallacy of his assertion at page 7, respecting the necessity of having an uneven number of archstones in the face.

As for all that part of his book which contains such problems as the following, viz.: "Given the three sides of a triangle to construct the triangle," and "from a given point near the middle of a straight line to draw a perpendicular;" it is, to say the least of it, most arrant twaddle. He might with equal propriety have added, given a pair of compasses with a point at one leg and a pencil at the other, to describe a circle.

However, I will say no more. For this time I have, as he observes, "done with him;" and I hope enough has been said to show Mr. Nicholson that his ideas have got a twist in their beds by no means adapted to skew-bridges, and that no species of brow-beating or invective on his part will be of the slightest use to him, while his book remains so very imperfect.

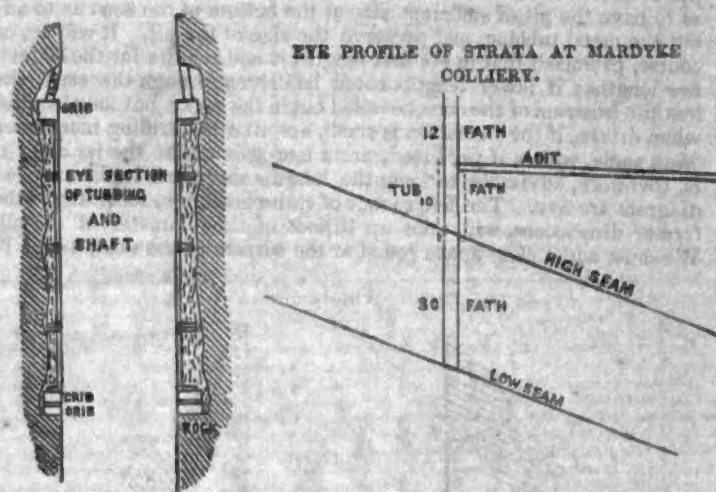
I am, Sir, your obedient servant,
W. H. BARLOW.

Brereton, August 16, 1841.

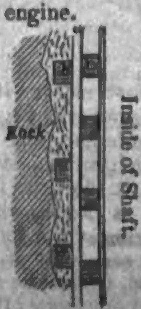
* The mode of obtaining the formula and construction is too long for insertion in this letter, but I will supply it if required.

CAST IRON TUBBING.

IN the Mining Journal there are some useful communications on Engineering Works connected with Mining, from which we select the following on "Tubbing of Shafts:" the first description is the application of a cast-iron tub, for the stopping back of water at Mardyke Colliery, the property of the Irish Mining Company, by Mr. Dunn, of Newcastle-on-Tyne, the first attempt in Ireland. The colliery contains two principal seams of coal, lying at an angle of one in three. The upper one, lying at the depth of 22 fathoms, is exhausted; and in order to win the second seam, at the depth of 30 fathoms further, the waters of the upper seam were required to be either pumped up to the natural adit (12 fathoms from surface), or to be forced up to that



point of discharge by tubbing. In order to give this project a fair chance, a piece of fire-clay, lying below the first seam, was taken advantage of as a foundation, and the shaft was rounded out to ten feet diameter. The base of tubbing is made to rest upon a pair of oaken cribs, fitted closely to the fire-clay foundation, and wedged from behind as long as ever a wooden wedge can be driven. This done, the cast-iron tub begins to be built, consisting of cast iron segments, four feet long, two feet high, and three-quarters of an inch thick, with a rectangular flange all round, of three inches; between each of these segments are placed half-inch (end ways) fir deal, wherein to wedge; the space between the segments and the rock is also stuffed with small stones, and tightened with wood. The top of the segments was completed by a wooden crib, which was stayed fast against the superincumbent rock, and then the whole fabric underwent the most severe wedging so long as any leak continued; and, when finished, the shaft was laid perfectly dry, with the feeder of water discharging out at the adit 12 fathoms above, and the sinking of the shaft resumed perfectly dry. The pressure against every square inch of the lower range of tubbing is equal to two and a half atmospheres, or about 37 lb. per inch, and, taking the average altitude at 36 feet, the whole tub is sustaining a pressure of about 81,200 tons; and so complete is the job, that the sinking has been since carried on without any pumping apparatus, whilst sufficient water is discharging at the adit as would give employment to a heavy engine.



It is often found convenient to surmount these tubs with a sufficient quantity of stone walling, to enable the wedging to be made effective.

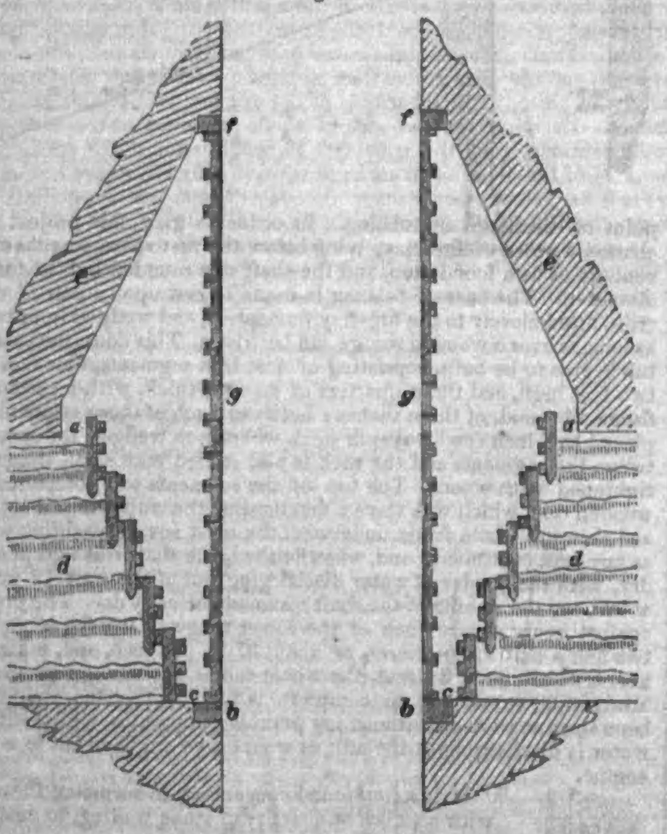
Some years ago Mr. Dunn effected the "winning" of a shaft, 30 fathoms deep, at Castle Comer, in the same county, by means of a plank tubbing, of 10 fathoms in length, constructed of three-inch planks, a, spiked against wooden cribs, b, and supported again by a range of inside cribs, c, which were in their turn clead with common deals; this mode of stopping water was practised for many years previous to the invention of cast iron tubbing.

ACCOUNT OF SOME PLANS ADOPTED IN THE NORTH OF ENGLAND OF SINKING THROUGH QUICKSAND.

By Edward Stanley, Engineer, Sunderland.

When a "winning" numbers amongst its contingencies an encounter with a formidable quicksand, the preparations are, or ought to be, well digested as to power and appliances to overcome it. The viewer, engineer, and master sinker, each in their respective departments, take a retrospect of the means used on former occasions at other places, selecting the improvements that each adopted from previous works, which give every new "winning" an opportunity of profiting by the experience of the past. Boring by rods having determined the distance the sand is situated from the surface, and also the thickness of the sand previously; this operation is requisite, as the pit has to be chambered or bevelled like the frustrum of a cone, for the purpose of driving the spiling and laying cribs, each length and round in the descent being within the previous one. Supposing, for instance, the pit is 15 feet diameter, and the sand five fathoms, or 30 feet, in depth, and the spiling and cribs averaging each six inches thick, and the length of the spiles six feet, it remains now to examine what must be the diameter of the base of the frustrum of the cone, bevelled out so as to have the pit of sufficient size at the bottom of the sand as to admit the metal tubbing, and preserve the size of the pit. It will be, of course, premised that in six feet lengths it will require for the 30 feet, five lengths; if fewer lengths could be driven through the sand, the less the frustrum of the cone bevelled out in the rock; but long lengths, when driven, if the deviation is small, are like the trifling inaccuracy of an angle, which, if produced, are a long way out at the far end; it is, therefore, advisable to keep the lengths short, and in the annexed diagram are five. The five rounds of spiles and cribs, according to the former dimensions, will take up 10 feet of the diameter of the pit. We must add a clear space round at the surface of the sand, *a a*, of 18

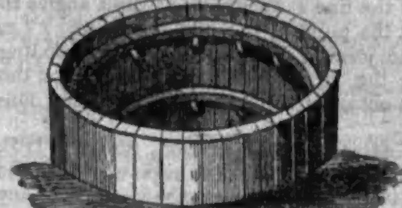
Fig. 1.



inches, which will add to the former diameter three feet, making it 13 feet. Further, we have to add the breadth of wedging crib, *b b*, cut at the bottom, and the space between its outer circumference and the lowest crib of the last spile, *c c*, together two feet each, which, added again to the 13 feet, makes 17 feet. This summary is the extra diameter over and above that of the pit, which we took at 15 feet, which gives 32 feet as the diameter of the base of the frustrum of the cone.

The height of this frustrum will depend upon the soundness of the limestone in contact with the sand. If not very sound, it must be carried further up, both for the safety of the sinkers and efficiency of the wedging crib at the top of the tub. The stratum of quicksand is shown by the letters *d d*, and the superincumbent limestone, *e e*, the top, or closing crib, *f f*, and the metal tubbing, *g g*; the manner of putting in which is by an intervening layer of deal sheathing, at the vertical and horizontal joinings, and subsequent wedging, has already been given in the *Mining Journal*. No letters of reference are put to the spiles and cribs, as they will easily be recognized, each spile having three cribs, at a distance apart of about two feet.

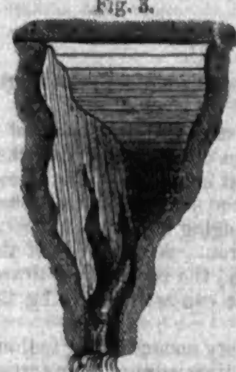
The following figure in perspective may give a more general idea of the mode of spiling and cribbing through the sand:—It will be perceived that the spiles are driven round the pit in the sand, and considerable attention and care is required on the first round—and the reason is, that when it is accomplished, and the three cribs inserted, the last of these acts as a guide for the circular insertion and driving of the succeeding set.



The cribs are kept up in their proper position by cleats or brackets (see fig.) till a sufficient external pressure keeps them tight. The spiles may be lighter near the surface of the sand if thought proper, and increase in thickness in the succeeding lengths with the pressure, but some consideration should at the same time be made for the large diameter requiring increased strength. It may, therefore, be consider d a prudent error to be too strong instead of too weak. A bird's eye view of the spiling, when complete, presents in principle an analogy to the elongation of a telescope.

It may appear paradoxical to a person unacquainted with the district, to be told that the quicksand sometimes presents itself in the form of a hard rock, requiring the liberal use of gunpowder to detach it. This stone is very porous, through which immense quantities of water filter, and which, by a continuous, running, increase the size of the apertures, along which are at the same time conveyed a large quantity of sand to the pit. This result is technically called "guttering," and, on any cessation of pumping, and consequent rising of the water, it increases to a great extent. As the water is being drawn out of the pit, its receding from the gutters brings along with it sand, and hence their enlargement.

Fig. 3.



The annexed fig. shows a gutter fallen on to the limestone roof. At the bottom will be perceived a stream proceeding from the far end, having tributary ones from each side. These, in some cases, keep filling up the bottom of the pit with sand, nearly as fast as it can be sent to bank. With a sand of this kind, the general aim is, to keep the water always down if possible, for it has been found that its rising invariably increases this guttering, which proceeds in long irregular chasms radiating from the shaft.

As "spiling" cannot be driven under circumstances of this kind, the cribbing and lathing is put into the pit in sections, as shown in the annexed fig., varying in depth according to circumstances, and as the sand can be excavated. These sections, when the round is complete, are kept together vertically by hanging deals, which are planks spiked to the previous rounds, or if it be the first round, to some suitable provision in the shaft; external pressure soon binds them horizontally. In some cases the sand becomes soft towards the bottom, and the sections are abandoned for spiling.

Fig. 4.

The foregoing details are enumerations of the resources hitherto applied, which appear, and, indeed, have been found in practice to answer best. In cases of difficulty, parties having works of this kind in hand are frequently favoured with friendly suggestions, the most popular of which appears to be the suspension of a cylindrical iron vessel, of proper diameter, which it is proposed to lower and lengthen at the top as the excavation proceeds. This suggestion has certainly feasibility about it, though it is said to have originated from an amateur.

The present article may not inaptly close with a brief notice of the Datton "winning," which is going on slowly but surely. The most determined and persevering spirit is shown by the owners (Messrs. T. R. G. Braddyll and Co.), and the viewer. The outlay of money is im-

mense, and the conviction is, that the colliery will be eventually "won." The engine power is ample, cancelling accidents, which have not been frequent. The settling of the sand on the bucket on one occasion was so dense as to be the means of lifting a column of 33 fathoms, of 22-inch pumps, by the spears on the starting of the engine. The sand is hard, and the feeder flowing principally from the south, has occasioned great delay and expense by guttering. Fig. 4 is a representation of the wooden segments that are being put in to get through the sand previous to metal tubbing, which is now about half penetrated. The liberality and public spirit of the owners deserves the most complete success, which all parties earnestly wish may be the case.

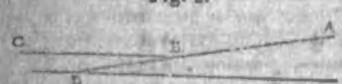
Another "winning" is now being made at Shotton, belonging to the Haswell Company, under the management of Mr. Thomas Foster, where the quicksand is very nearly arrived at. Should "any thing fresh" be brought into play at this place, either in getting through the sand, or the surface arrangements, it will appear in the Journal, with suitable illustrations, so far as it can be done without injury to the proprietors.

DREDGE'S SUSPENSION BRIDGES.

SIR—May I request the favour that the following remarks (on an anonymous communication, signed G. F. F., which appeared in your last Journal), may be inserted in your next.

The curve of a taper chain either connected or unconnected with the platform, is not a catenary, but one of very different properties; it might be easily demonstrated, but let that pass—for your correspondent makes as great a mistake in regard to the action of the oblique suspending rods in connection with the chains, and which is the only part of his letter I shall notice.

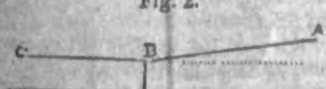
Fig. 1.



C, the centre of the bridge.

Let A B C represent a portion of the chain of a suspension bridge, B D an oblique suspending rod having the same inclination with the horizon as that portion of the chain B A; then will the strain upon B D, and of course upon B A, be proportional to the secant of the angle D A makes with the horizon, and there being no resolution of forces from the point B, there can be no tension in the direction B C.

Fig. 2.



C, centre of the bridge.

Again, put A B C part of the chain of a common suspension bridge, B A forming the same angle with the horizon as A D did in the former curve; then will the strain in the direction B A be proportional to the secant of the angle which it makes with the horizon (or the same as before), but by a resolution of forces, there would be a tension in the direction B C, α as the radius, which tension must be borne by a sufficient quantity of iron, and that iron causing a strain on the curve α as the secant of the angle B A makes with the horizon.

I shall take no further notice of this anonymous communication, but if your correspondent wishes further information, he must affix his name to his next letter, and then be careful what he says, for though the diagram he shows is totally different from the form proposed, his demonstration if carried out, would only tend to support that principle he is attempting to refute, and the several structures either in course of, or about to be erected in various parts of the kingdom, will at once silence every futile objection that can be raised against it.

I remain, Sir, your humble obedient servant,

J. DREDGE.

Bath, August 16, 1841.

P.S. I would refer your readers who may be interested in this subject, to the drawings which have appeared in your Journal, and they will at once perceive that there is not the slightest similitude between them and that represented by your correspondent in the last number.

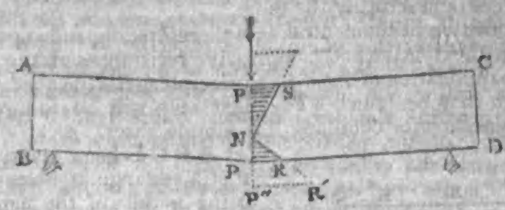
_ We know not what right Mr. Dredge has to make the insinuation which he has done in the above letter, with regard to an "anonymous communication." The article of G. F. F., was written without the slightest taint of presumption or slur upon Mr. Dredge's invention, it was a fair scientific enquiry into its merits, and such a one as every Inventor must be ready to encounter, if he be desirous of introducing to the scientific world any new form or invention. For the purposes of free and open discussion, we do not see the necessity of correspondents giving their names—and we shall leave it to G. F. F. to reply to Mr. Dredge's remarks.—EDITOR.

ON THE TRANVERSE STRAIN OF BEAMS.

BY HERBERT SPENCER, C.E.

THE following paper is an outline of a new system of investigating the laws of the transverse strain, differing from the usual method, in as much as it depends solely upon the position of the neutral axis. The results as here given, will probably not be considered sufficiently concise for practical application; but they are published in the hope that something useful may be elicited.

Fig. 1.

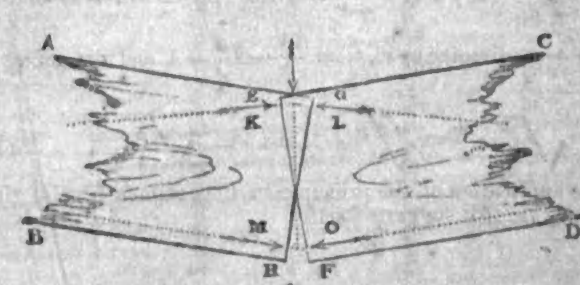


1. Let A B C D be a piece of timber, subject to the transverse strain in the direction shown by the arrow; and let P P′ be assumed as the plane of fracture, and N the position of the neutral axis. Take any line P′ R, to represent the resistance to fracture of all the fibres in the bottom lamina, then by the theory of the lever, if N, R, be joined, and any line be drawn parallel to P′ R, and terminated by N P′, and N R, it will represent the relative effect of all the fibres in its latitude, and therefore the whole triangle N P′ R, will denote the resistance to fracture of all the fibres in tension. In the same manner, a triangle N P S may be assumed, which shall represent the resistance of all the fibres in compression.*

2. Now the mode of action of the fibres in resisting the force impressed, involves the necessity of the equilibrium of the compressive and tensive resistances, about the transverse line through N, that is the neutral axis; for suppose a saw-gate made down the line P N as far as N, and the force to be then applied; a deflection will immediately take place, and the surfaces of the opening will come into close contact. Carrying out the idea it would appear, that the deflection would continue, until the resistance to compression in the upper portion P N of the plane of fracture, is equal to the resistance to tension in the lower portion; or that in the uncut beam, the neutral axis arranges itself so that these forces are in equilibrium.

As it is this theory upon which all that follows depends, and which if disproved, will invalidate the succeeding calculations, it may be well to give a further illustration.

Fig. 2.



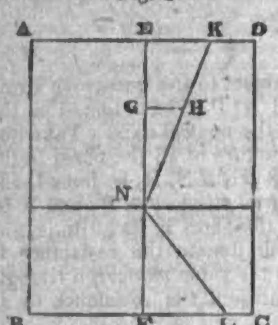
Let A B C D be a piece of wood as before, subject to transverse strain, and let E F and G H be the planes of fracture; (the diagram being necessarily greatly exaggerated to make the action clear) draw the arrows K, and O, perpendicular to E F, and L, and M, perpendicular to G H; then K, and L, will represent the direction of the resistances of certain fibres to compression, and M, and O, those of the resistances of other fibres to tension; (the forces extending the fibres are acting from H towards B, and from F towards C, and the resistances will obviously be in the reverse directions)—now K, and O, being perpendi-

* This theorem affords a simple demonstration, that the strength varies as the square of the depth; for if the depth be increased, (the neutral axis remaining constant) so that N P′ becomes N P″, the original supposition being carried out, the triangle N P″ R′ will denote the new tensive resistance; but the triangle N P″ R′, is to the triangle N P′ R, as $(N P'')^2$ to $(N P')^2$; that is the resistance of the fibres in tension, varies as the depth square, and the same will be true of those in compression.

cular to E F are parallel, and the same may be said of L, and M; hence if produced they will form a parallelogram, and the resultant diagonal of K, and L, will be equal, and in the opposite direction to that of M, and O; that is, the forces will be in equilibrium; but if, K, and L, be greater than M, and O, their resultant diagonal will also be greater, and motion must ensue, that is such a state of things cannot exist. And what is true of these single forces, will be true of the forces of all the fibres collectively; or the resistances to compression and tension will be equal. It may be said that this explanation, involves the necessity of the centre of motion N, being midway between the contending forces, and that that does not obtain, in the case in point; but this does not prevent its application, for the resistances to tension though exercised nearer to the neutral axis, are greater in amount, so that the effect is practically the same.

3. The position of the neutral axis therefore, depends upon the ratio between the tensive and compressive resistances of the material, and by the application of the above principle, with the necessary data, its situation may be found. The next step will be to develop the general expression for obtaining it in simple cases.

Fig. 3.



Let A B C D be a transverse section of a rectangular beam; assume N as the middle of the neutral axis, and through it draw the central line E F, and in F C take any line F L, to represent the resistance of all the fibres in the line B C; join N L, and the triangle N L F will denote the resistance of all the fibres in tension. Make N G, equal to N F, and draw G H perpendicular to it, and let G H, be to F L, as the resistance to compression, is to the resistance to tension in the material in question; join N H, and produce it to K, then the triangle N E K will represent the resistance of all the fibres in compression, and will consequently be equal to the triangle N F L. Let x equal N F, the distance of the neutral axis from the bottom; take d for the depth, and let p and q stand for F L and G H respectively; that is, let them denote the tensive and compressive resistances.

Now by similar triangles N G : G H : : N E : E K,

or $x : q :: d-x$: E K, or E K $= \frac{q\,(d-x)}{x}$,

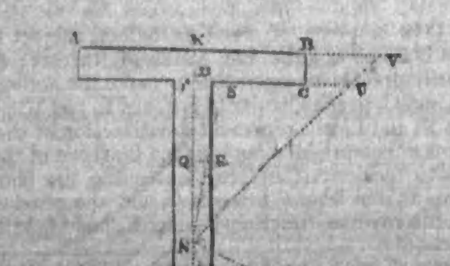
$\therefore \frac{(d-x) \times \frac{q\,(d-x)}{x}}{2} =$ area of triangle N E K; and $\frac{p\,x}{2} =$ area of triangle N F L; hence we have the equation,

$\frac{p\,x}{2} = \frac{q\,(d-x)^2}{2\,x}$ or $p\,x = \frac{q\,(d-x)^2}{x}$, hence $p\,x^2 = q\,(d-x)^2$ or $\frac{p}{q}\,x^2 = d^2 - 2\,dx + x^2$. dividing by x^2, $\frac{p}{q} = \frac{d^2}{x^2} - 2\frac{d}{x} + 1$ and extracting root

$$\frac{d}{x} - 1 = \sqrt{\frac{p}{q}} \text{ or } \frac{d}{x} = \sqrt{p} + 1, \text{ and } x = \frac{d}{\sqrt{\frac{p}{x}} + 1} \qquad (1.)$$

4. The application of the principle to the common form of girder, is the next case that suggests itself.

Fig. 4.



Let A B C D E F G H be the section, assume N to be the middle of the neutral axis, and through it draw the central line K L, and in the line E O, take a line M E, to represent the resistance to fracture of all the fibres between E, and O, and for the sake of convenience, let M E be equal to half E O; join N E, N F, and let N F, and H G, produced, meet in P.

Make N Q, equal to N M, and draw Q R perpendicular to it, and let Q R, be to M E, as the compressive resistance in cast iron, is to the tensive resistance; join N R, and produce it to S, and as T S : T D, so make T U : T C; join N U, and let N U, and A B, produced, meet in V.

Then in accordance with the principles as applied in the last case, the figure N L P F E, will represent the resistance to fracture, of all the fibres below the neutral axis; and the figure N S U V K, the resistance of all those above, and these will be equal.

Now let x = N L the distance of the n. a. from the bottom.

d = the whole depth.
d' = depth of top flange.
d'' = depth of bottom flange.
b = breadth of top flange.
b' = ditto of middle rib.
b'' = ditto of bottom flange.

And as before, let p and q represent M E and Q R respectively.

Then N M : M F : : N L : L P or $x - d'' :: \frac{p\,b''}{b'}$* $:: x$: L P

or L P $= \frac{x \times \frac{p\,b''}{b'}}{x - d''} = \frac{p\,b''\,x}{b'\,(x-d'')}$. Therefore the area of the figure N L P F E will be represented by,

$$\frac{p\,(x-d'')}{2} + d''\left(\frac{\frac{p\,b''}{b'} + \frac{p\,b''\,x}{b'\,(x-d'')}}{2}\right) =$$

$$\frac{p\,(x-d'')}{2} + \frac{p\,d''\,b''}{2\,b'} \times \left(1 + \frac{x}{(x-d'')}\right)$$

Again, as N Q : Q R : : N T . T S,
that is $x - d'' : q :: d - d' - x$: T S,

or T S $= \frac{q\,(d-d'-x)}{x-d''}$.

But T D : T S : : T C : T U or $p. : \frac{q\,(d-d'-x)}{x-d''} :: \frac{b\,p}{b'}$† : T U

that is T U $= \frac{\frac{b\,p\,q\,(d-d'-x)}{b'\,(x-d'')}}{p} = \frac{b\,q\,(d-d'-x)}{b'\,(x-d'')}$.

And N T : T U : : N K : K V or

$d - d' - x : \frac{b\,q\,(d-d'-x)}{b'\,(x-d'')} :: d - x$: K V,

hence K V $= \frac{\frac{b\,q\,(d-d'-x)\,.\,(d-x)}{b'\,(x-d'')}}{d-d'-x} = \frac{b\,q\,(d-x)}{b'\,(x-d'')}$.

And the area of the figure N S U V K, will therefore be represented by

$$\frac{d-d'-x}{2} \times \frac{q\,(d-d'-x)}{x-d''} + d'\left(\frac{\frac{b\,q\,(d-d'-x)}{b'\,(x-d'')} + \frac{b\,q\,(d-x)}{b'\,(x-d'')}}{2}\right)$$

* As $\frac{b'}{2}$ represents the resistance of all fibres between O and E; $\frac{b''}{2}$, will denote that of all those between W and F; and $\left(\frac{b''}{2} \div \frac{b'}{2}\right)$ that is $\frac{b''}{b'}$, will express the multiple, that the number of fibres between W and F, is of the number between O and E, and if p equal the resistance of fibres between O and E, then $p \times \frac{b''}{b'}$ will equal that of all fibres between W and F. It is necessary that the quantity should be put in this form, instead of the simple fraction $\frac{b''}{2}$, in order that the value of L P, should involve the term (p).

† The last note explains this also.

But, area N L P F E = area N S U V K.

Hence we have the equation,

$$\frac{p\,(x-d'')}{2}+\frac{p\,d''\,b''}{2\,b'}\times\left(1+\frac{x}{(x-d'')}\right)=\frac{q\,(d-d'-x)^2}{2\,(x-d'')}+$$

$$\frac{q\,d'\,b\,(2\,d-2\,x-d')}{2\,b'\,(x-d'')}.$$ And multiplying by $2\,(x-d'')$,

$$p\,(x-d'')^2+\frac{p\,d''\,b''}{b'}\times(x-d''+x)=q\,(d-d'-x)^2+$$

$$\frac{q\,d'\,b\,(2\,d-2\,x-d')}{b'},\ \text{or}\ \ p\,b'\,(x-d'')^2+p\,d''\,b''\ (2\,x-d'')=$$

$$q\,b'\,(d-d'-x)^2+q\,d'\,b\,(2\,d-2\,x-d').$$

Expanding the squares we have

$$p\,b'\,(x^2-2\,d''\,x+d''^2)+p\,b''\,d''\,(2\,x-d'')=q\,b'\,(d^2+d'^2+x^2+$$
$$2\,d'\,x-2\,d\,d'-2\,d\,x)+q\,d'\,b\,(2\,d-2\,x-d'),\qquad\text{or}$$

$$p\,b'\,x^2-2\,p\,b'\,d''\,x+p\,b'\,d''^2+2\,p\,b''\,d''\,x-p\,b''\,d''^2=$$
$$q\,b'\,(d^2+d'^2-2\,d\,d')+q\,b'\,x^2+2\,q\,b'\,d'\,x-2\,q\,b'\,d\,x+$$
$$q\,d'\,b\,(2\,d-d')-2\,q\,d'\,b\,x.$$

And by transposition,

$$(p\,b'-q\,b')\,x^2+(2\,p\,b''\,d''-2\,p\,b'\,d''+2\,q\,b'\,d-2\,q\,b'\,d'+$$
$$2\,q\,d'\,b)\,x=p\,b''\,d''^2-p\,b'\,d''^2+q\,b'\,(d^2+d'^2-2\,d\,d')+$$
$$q\,d'\,b\,(2\,d-d'),$$

$$\text{hence}\ x^2+\frac{2\,(p\,d''\,(b''-b')+q\,b'\,(d-d')+q\,d'\,b)}{p\,b'-q\,b'}\,x=$$

$$\frac{p\,d''^2\,(b''-b')+q\,[b'\,(d-d')^2+d'\,b\,(2\,d-d')]}{p\,b'-q\,b'}$$

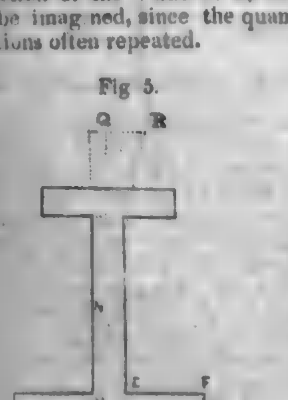
And completing the square, extracting the root, &c., we have

$$x=\sqrt{\left\{\frac{p\,d''^2\,(b''-b')+q\,[b'\,(d-d')^2+d'\,b\,(2\,d-d')]}{p\,b'-q\,b'}+\left(\frac{p\,d''\,(b''-b')+q\,b'\,(d-d')+q\,d'\,b}{p\,b'-q\,b'}\right)^2\right\}}-$$

$$\frac{p\,d''\,(b''-b')+q\,b'\,(d-d')+q\,d'\,b}{p\,b'-q\,b'}\qquad(2.)$$

And thus we obtain the situation of the neutral axis. It must be admitted that the equation is rather forbidding in appearance, but the reduction of the value of x, will not be found so tedious as may at first be imagined, since the quantities are simple, and the same combinations often repeated.

Fig 5.



5. Assuming that N L, the distance from the centre of the neutral axis, to the bottom of the girder, has been found by equation 2; we shall at once be able to determine the dimensions of a rectangular beam, whose strength shall be equal to that of the girder.

The figure being constructed as before, produce N L to O, and N E to P, and let O P be drawn at right angles to N O, the distance L O being supposed to be such, that the area of the figure M E P O, may be equal to that of the figure M L G F, and consequently, that the triangle N O P, and the figure N L G F E, may have equal areas. Since therefore the area N L G F E, which represents the resistance to fracture of that portion of the girder below the neutral axis, is equal to the triangle N O P, which will indicate the resistance of the middle rib, produced to an imaginary point O: by finding the distance L O, we shall obtain the dimensions of a simple rectangular rib, having a strength equivalent to that of the portion of the girder below the neutral axis N.

Let the known distance N L, be represented by (a), and L O by (x), and the other dimensions remain as before.

Then $a-d'':\frac{b''}{2}::a:$ L G or L G $=\frac{a\,b''}{2\,(a-d'')}$,

and $\dfrac{d''\left(\dfrac{b''}{2}+\dfrac{a\,b''}{2\,(a-d'')}\right)}{2}=$ area of figure M L G F.

Again, $a-d'':\frac{b'}{2}::a+x:$ O P or O P $=\frac{b'\,(a+x)}{2\,(a-d'')}$.

And $\dfrac{(x+d'')\times\left(\dfrac{b'}{2}+\dfrac{b'\,(a+x)}{2\,(a-d'')}\right)}{2}=$ area of figure M E P O,

hence, by the construction we have the equation,

$$d''\left(\frac{b''}{4}+\frac{a\,b''}{4\,(a-d'')}\right)=(x+d'')\times\left(\frac{b'}{4}+\frac{b'\,(a+x)}{4\,(a-d'')}\right)$$

$$\text{or}\ \frac{d''\,b''}{4}\left(1+\frac{a}{a-d''}\right)=\frac{b'\,(x+d'')}{4}\left(1+\frac{a+x}{a-d''}\right)$$

Multiplying by $4\,(a-d'')$ we have,

$$d''\,b''\,(a-d''+a)=b'\,(x+d'')\times(a-d''+a+x)$$

$$\text{or,}\quad d''\,b''\,(2\,a-d'')=b'\,(x+d'')\times(2\,a+x-d''),$$

$$\text{and,}\quad d''\,b''\,(2\,a-d'')=b'\,(x^2+2\,a\,x+2\,a\,d''-d''^2)$$

$$\text{hence,}\quad\frac{d''\,b''\,(2\,a-d'')}{b'}=x^2+2\,a\,x+2\,a\,d''-d''^2$$

$$\text{by transposition,}\ \frac{d''\,b''\,(2\,a-d'')}{b'}+d''^2-2\,a\,d''=x^2+2\,a\,x,$$

$$\text{completing the square,}\ \frac{d''\,b''\,(2\,a-d'')}{b'}+d''^2-2\,a\,d''+a^2=x^2+2\,a\,x+a^2$$

$$\text{extracting the root,}\ x+a=\sqrt{\frac{d''\,b''\,(2\,a-d'')}{b'}+(d''-a)^2},$$

$$\text{or,}\quad \text{N O}=\sqrt{\frac{d''\,b''\,(2\,a-d'')}{b'}+(d''-a)^2}\qquad(3.)$$

The points Q and R, having been assumed in the same manner as O and P, we shall have the proportion, O P : Q R : : p : q, and as the triangles N Q R, N O P, are equal,

O N : N Q inversely as p to q,

that is, N Q $=\dfrac{p\times\text{O N}}{q}$,

and the whole depth, O Q $=$ N O $+\dfrac{p\times\text{N O}}{q}$ (4.)

It will be seen therefore, that by applying the equation No. 2, to ascertain the position of the neutral axis, and subsequently Nos. 3 and 4, we obtain the depth of an imaginary rectangular beam, having the same thickness as the middle rib, whose strength shall be equal to that of the girder, thus bringing us within the reach of the usual formula.

It may be as well to repeat the remark made at the commencement, that this system is not proposed for practical application in common cases; the essay being merely intended, as an exposition of another mode of viewing the action of the transverse strain, and as affording a means, should the principles be found correct, of testing the accuracy of the common approximate methods.

Derby, August 11, 1841.

Pacific Steam Navigation.—Extract of a letter received by the Directors of the Company from Mr. Wheelwright, dated Lima, April 28, 1841.—"Captain Peacock arrived here on Saturday, the 24th, having consumed nothing but Chili coal during the voyage:—his calculations have been most beautifully carried out, for he has not been 15 moments out of his time, on arriving at and sailing from each port in the voyage, from Talcahuano to this place, a distance of nearly 1,700 miles; and it affords me pleasure to remark, that his zeal in the cause of the Company merits the highest praise. His ship is, I am happy to state, well regulated with a due regard to economy, and the several departments are most judiciously arranged."

CANDIDUS'S NOTE-BOOK.

FASCICULUS XXX.

"I must have liberty
Withal, as large a charter as the winds,
To blow on whom I please."

I. It is a most fortunate circumstance that the Croakers, and Screech-owl school of philosophers, both contradict each other, and are contradicted by experience; else we should have a most woful time of it, were we to pay attention to all their notable advice in regard to the *hygeine* regimen of architecture. At one time the public—at least the *nervous* public—are scared by being told that St. James' Park is the seat of malaria, and by being made to believe that Queen Victoria actually dwells in the midst of pestilence, although she does so only metaphorically, like all sovereigns, amid the moral malaria of a court. Next come the ventilation folks, who would fain persuade us that we are now all suffocating ourselves in rooms whose atmosphere is incapable of supporting animal life, owing to our present defective modes of construction. And indeed were the atmosphere in our houses as oppressive and suffocating as their doctrines, it would be so deadly, that I question if any sort of ventilation could correct it—except it were the ventilation occasioned by a hearty laugh. It was certainly a very great piece of presumption on the part of the Old-Londoners to presume to exist, as they did, cooped up in narrow lanes and alleys, where the different stories of the houses, projected over each other, so that the occupiers of the garrets could *Pyramus-and-Thisbe* with their opposite neighbours. No less impertinent is it that even nowadays, people will presume to fancy they can contrive to exist huddled together in the cabin of a steamer, in an atmosphere reeking with frowsiness!—and sleeping in boxes, not very much bigger than—and certainly not so well aired as, an ordinary dog-kennel. Did I wish to set up a fussy doctrine of my own, I should say that sea-sickness is chiefly occasioned by the horrible agglomeration of impurity condensed between the decks of a ship. Nevertheless instead of keeping quietly at home in their own comfortable rooms, many people are seized every season with a desperate fit of fidgetiness, until they can regale themselves with fresh air in a steamer, and squeeze themselves into poking little rooms in crowded lodging-houses, peopled from Cockney-Land, in a place that looks just like a suburb of it.—Well if the Ventilation folks can frighten them a bit, they may so far do good. If too, their doctrine be worth anything, an act ought to be passed making it a cognizable offence, for any one to get a genteel *squeeze*, especially if their "saloons," as the newspapers call them, consist of no more than two ordinary-sized upstair parlours, with a little cabin beyond them, made to perform the part of Boudoir—for that 'night only'. As for that, it matters very little how many or how spacious the rooms themselves may be, if more persons are to be crammed and jammed into them than their area can well contain; for it is no less absurd to attempt to pour a gallon into a quart mug, than a quart into a pint one. "Was not the squeeze, last night at ——'s actually insupportable?" was a question once asked, and produced the following reply: "It was, indeed, tremendous, but not insupportable, since the gentlemen supported the ladies, and the ladies supported the gentlemen."

II. Though the first has been a long one, I must give a second act to the farce of Ventilation. If the Terrifiers be in the right, ought not all under-ground kitchens, servants' halls and other rooms, to be strictly prohibited?—or does it not matter whether the High-Life-below-stairs part of the creation are suffocated or not? We are told that those whose avocations compel them to be chiefly in the open air, are proportionable healthier than others; and in proof of this we are perhaps referred to the striking difference between a ploughman, and a weaver;—a gamekeeper ranging about the woods, and a tailor doomed to sit all day upon the piece of wood called his shop-board. In all such arguments the stress is laid exclusively upon the single circumstance that happens to make for it. Here, the difference is attributed entirely to air,—to exercise, diet, &c., nothing. Should a tailor chance to drink himself into his grave, the "Ventilators" would seize upon him—not exactly after the fashion of body-snatchers,—but as an instance of the deplorable consequences of the want of fresh air. Well but put exercise to fresh air, and good appetite and its wherewithal, to them both, and they achieve wonders.—Yet, your jolly, jovial, foxhunter dies at the venerable age of forty, while some poor feeble, sickly, bookworm who immures himself almost constantly within his study, outlives another foxhunting generation, keeping among the living for four-score years.—It is unnecessary to repeat so well known an anecdote as that of Fontenelle's "slow poison;"—which, by the by, is only one of the slow poisons which certain ingenious gentlemen have from time to time invented for the laudable purpose of alarming their neighbours. I remember once reading an awful medical invective against carpets,—the general use of which was said to have rendered people less healthy and long-lived than their ancestors who were unacquainted with such foolish luxuries. Yet I make no question but that the Doctor himself had his rooms carpetted, as well as his neighbours.

III. The author of the World of London, in Blackwood's Magazine, speaking of the building at the corner of Downing-street, observes that it is by "Sir John Soane, of Bœotian celebrity, who, together with Nash, has done so much to deprave our metropolitan taste in architecture, that another invasion of the Goths and Vandals were more to be desired than deplored." Indeed it is truly wonderful, and not a little scandalous also that two such Bœotians as Soane and Nash should have obtained fat-headed patronage to the extent they did, and been permitted to play their tasteless and extravagant pranks, while John Bull paid the piper. Both of them were addicted to the expensive practice of experimentalizing with their buildings, constructing, pulling down again, and reconstructing afresh, as if alterations of that kind cost no more time or money than they would have done in a drawing. Such was notoriously the case with Buckingham Palace, such too was it with the Downing Street edifice, which after all is unfinished, and doomed never to be finished, it having been commenced so Bœotianly and bunglingly that it cannot possibly be continued Northwards without either being twisted, or else projected into the street, so as to extend across the foot-pavement. Therefore it is likely to remain as long as it lasts, in statu quo,—a monument of its architect's taste, and his great affection for the "scored pork" style, and likewise of his extraordinary ingenuity, the entablature being most artfully contrived to block up a series of mezzannie windows just behind, and separated from it merely by an interval of three or four inches. It is lucky for Soane that this fault has escaped the notice of his friend Gammon, who has just found out what he might have discovered many years ago that Soanean Gothic is very *so-soish* stuff. But poor little Gammon's esteem for Soane, has steamed itself quite away, and is now utterly evaporated.

IV. One of the least exceptionable samples of Soane's taste is the basement of the State Paper Office, St. James' Park, where he has introduced a rather novel mode of rustication, which is at once rich and sober in effect. There are also one or two other good points about that building, although as a whole it is not particularly happy. It appears to be no more than a private house, and even as such by no means a large one. Most certainly there is nothing whatever in the exterior to indicate, or even remotely suggest for what particular purpose the building was erected. In regard to Soane's works generally, it is somewhat remarkable that they have been so very little noticed by foreigners, either for approbation or the contrary. The venerable architect's affection or appetite for his "scored pork" was so inordinate, that he did not scruple at times to employ that singular species of decoration even internally.

HINTS ON ARCHITECTURAL CRITICISM.—Part 1.

It is a very delicate thing to insist on primary principles, when the very suggestion that a knowledge of those principles is necessary, seems almost like a whisper of insult. Thus, to intrude with an alphabet for the critic, in an age when men have grown grey in criticism, becomes scarcely pardonable;—nay it would be almost dangerous, but for the suggestive attitude the writer would assume, in pleading anew those elemental truths, by which alone the critic can arrive at an equitable conclusion. If therefore, out of regard perhaps for one or two, (who have viewed the vision of Palladio's family with horror, as if the harmless race of a Banquo had been passing in review,) I draw for a little a veil upon the past to introduce a new subject, and appear on a new scene, the spectator must judge me mildly; for I am no literary coxcomb, puffing myself into notice, but anxious,—deeply anxious, to remove some of those weeds, which entangle around to choke the beautiful flowers of a still more beautiful art.

The subject of consideration, is criticism, which, like politics, betrays many currents of opinion, and many hostile enthusiasts.

It is right that there be enthusiasm, for without it art would slumber, but it is also right that every persuasive argument be adduced, to free the mind from certain prejudices, which lead the enthusiast astray; and it is a commendable task, to try at turning these various currents of opinion into one deep channel, the original source of which shall be "truth."—This preface must suffice. I am satisfied after this attempt at beckoning the attention towards what I would present, to leave it to the reader to judge, whether I quibble merely for indefinite

purposes, or strive with the noble and the proud aim of ameliorating my country's art.

First, what is criticism?—Criticism is a branch of polite science, and when found in union with art becomes an index to its position. From this arises its importance. It is also a court, where the several disputes of art are brought to issue, and upon the decisions of which the public opinion stands: hence arises its influence. The foundation of its laws, is based on sense, imagination, and judgment, as the three natural powers it attempts to move. Its laws of adjudication vary according to the claims of art, and according to the nature of appeal; and from the labour necessary to frame these laws, and to apply them, is inferred the necessity of their adoption. An appeal to the judgment of criticism, is based upon plausibility, and implies public assent to certain principles; these however, critics as counsel in the social contentions of art, quarrel upon, whilst the judge "nature" sits to disentangle and apply them. The arguments vary first, according to the art, and secondly, accordingly to the nature of its claim,—its claims being always in the shape of some emotion, (emotion being the aim of the affecting arts) the fitness, or unfitness of which, for the present is immaterial. The institution of the court itself, is founded upon presumed error, as implying an uncertain acquaintance with those laws, which are the philosophy of our taste. It follows then, in order to meet the wisdom of such an institution, that the principles which detect the propriety, or expose the error of appeal, should be free from arbitrary application. It is first then, upon the necessity of a judgment in matters of art, secondly,—upon the required clearness of the laws of judgment, and, thirdly, upon the arbitrary interpretation of those laws, which interpretation, I for the present assume to exist, that I am induced to throw out a few hints on criticism, which I hope will be received by the reader with a politeness due to the subject, however in exhibiting this politeness, he may disguise a dislike to what may appear officious interference in the writer. However these hints may be generally received, the man of correct taste knows that it is not an irrational task, to dissect those principles which aid us, or ought to aid us, as we either feel or affect a love for the great examples of art. He knows that about architectural excellence there is an air of mystery: so that without any implied reproach upon the elegance of any choice hitherto made, or which may be made, he would prefer our being guided by principle, rather than by instinct, in our search after the beautiful, and that instead of wrangling over fragments, like beasts over carcases, he would choose an explanation of the real basis of choice, of which a noble profession cannot be ashamed. The very circumstance of our choice being a habit, requires that some effort be made to enlarge and unfetter the mind, so that by infusing into it those ideas which are the very key to effective design, we may stand in rivalry with the ancients;—adopting if we please their beauties, but adopting them from choice, not from necessity.

I feel strongly on the subject, because it is so important that architecture should rank amidst the poetic arts, and that the attainment to architectural excellence, shall be only by the acknowledged effort of genius. I feel strongly too, because I conceive it is owing to our negative character as artists, and our supine imitation, that critics rise no higher in their views. The architect of original bent, feels the incompetency of ordinary men to discuss his claims: a critic in his idea, being a man who has only read through Creasy or Stewart, or if learned in Christian architecture, has his dictionary of reference only in some convenient examples. He is unfamiliar with the man of that severe yet elegant mind whose opinion he covets. He has been deceived in fancying architecture an art, where conception, the inseparable companion of genius might alight. The root of the defect at once appears in criticism, which is confined to certain laws inimical to invention. The evil of this criticism is, that it limits that range of mind which every other poetic art allows, and is either founded on a presumption against the poetry of the art, or against the ability of its students. If in the former ground it is inconsistent, because that combination of parts, with the ancients so fortuitous, being deemed by many the monopolist of beauty, shows an argument then against the poetry of the art, for poetry is confined to no set disposition of forms. If on the latter ground it is a libel upon the genius of our nation, and stagnates by its mean policy, those efforts which might introduce fresh beauties amongst us. I admit that our rules are protective, and exclude many incongruities; but would it not be more honourable to make the antique amenable only to fresh creations? very possible if as artists we catch the spirit of our masters. It being evident then, that our art for inventive beauty is far behind the other arts, with which it claims sisterhood, and that however good this claim to equality may be, it does not appear either from the pen of the critic, or the example of the architect, to be so dignified; it follows, as a natural consequence, that to maintain this kindred claim, there should be shown a similarity of laws, by which the composition is governed, and by which the emotions are engaged: it follows too, if this be the case, that then, our laws of criticism are erroneous, or capricious, being essentially at variance with those of other arts.

In watching the progress of a design, in either art, to its completion, that is in observing that anatomy of thought out of which the composition is formed, we may perceive a relationship existing, although we do not yet admit its existence. We read an able critique upon poetry, music, sculpture or painting, and the mind responding with ready fidelity to truth, becomes at once conscious that it hears in that criticism, but the echo of its own suggestions: but architectural criticism we do not feel in this way, and purely because its compositions are not criticized on the same ground, the mechanical being ever judged as in partial skirmish with the poetical. Architecture however, is not more mechanical than the other arts, for the conception which occupies the brain of the poet, or the painter, can only acquire a correct and tangible shape by a process of adjustment. Calculation enters into the design; associations are dwelt upon; and the sentiment which is to appear is only featured by a careful arrangement. Music, amidst all its sweetness and harmony, has its mechanism. The rush of chords, the softer modulation, independent of the art, which, if I may so speak, can embody for the ear its anticipations, is but the sale of a passion, or a sentiment, shaped and tutored in the mind, with reference to situation, circumstance, time and probability. Each art is alike too in its finished performances: they are so many appeals to the mind through the senses; music, through the ear, sculpture, painting, and architecture through the eye, poetry through the eye and ear, and it is upon this beautiful and exquisite web of sensation, that the power of art moves. But supposing that architecture be equally with the other arts, a mirror where the eye can seek objects, which the mind may enjoy, a barrier intrudes itself at once, in the shape of that word, "taste," (which like the ghost of Junius assumes a variety of shapes) to make it doubtful after all, whether there can be shown common grounds, upon which the feelings are moved. It will be necessary then, to define this word "taste," because if this be unexplained, we may be only right by chance.

It has been deemed a fruitless task, to reconcile to a principle the varying opinions current upon the same object in arts, each of which is termed the opinion of taste, because of the different degrees of sensibility and imagination found in different minds, and because it has been observed, that the same object, which is viewed carelessly by one man, fills another man with exquisite delight. Strange as these differences may appear, they are all to be traced to one source. The taste of a man which is a progressing principle, receives its perfect development only from time. Taste which in infancy is mere sense, becomes improved as imagination and reason blend to assist it.—Taste resulting not from a simple idea, but from the union of reason and imagination, varies then not according to that chance inseparable from a simple notion, but according to the effort of the imagination and the exercise of the judgment, the latter quality of the mind being a determinable thing, whose degree of ability is proportioned to the attention and care bestowed. Imagination too, though a power extremely elastic, resembles when engaged with architecture, either more or less that faculty we denominate "taste," for its essential power then lies in tracing resemblances, and it is either perfect or advancing towards perfection, according to the degree of judgment in simultaneous exercise. Thus taste is subject to degree, and according to this degree of taste in different individuals, we find the degree of refined pleasure which a work of art produces. Taste which is a habit is therefore imperfect taste, because inimical to progression. Hence habit which is the origin of our views in a great measure, may explain the source of our architectural taste.

Independently of this definition of taste, and the grounds of its support, there is a further difficulty attendant upon its application to architecture, from the circumstance of there being little or no direct appeal to the sympathies, which the painter, the poet, and the sculptor, so powerfully affect, and which the rudest mind intuitively feels, without previous study, to acquaint him with the source of his emotion. This is one reason why public opinion varies so much; men untaught, with their judgments unassisted, feeling that emotion is the object of the art, are precipitated into hasty conclusions, just because their sympathies cannot be awakened. A correct taste in architecture is more difficult than in any other art, because the ideal resemblances affecting the mind are more remote: and this is the reason why the taste is pleased by figures, pictures, statues or striking ornaments, to the prejudice very often of a taste strictly architectural:—the mind being conducted towards familiar objects.

The essential difference between architecture and the other poetic arts, consists then in this suggestive character, whilst the poetry it exhibits, appears in expression, attitude, or relative position. It has however, all the attributes of the other arts at command, and which it

makes subsidiary; and thus its claims to criticism are as strong and as important, as the noble art of the painter, or the sculptor. Having then endeavoured to state that architecture is equal to the other arts, in its claims to liberal criticism, I shall reserve it for my next to show the origin of its effects upon the mind, by a definition of that faculty, inherent in us, by which we extract emotion from attitude, proportion and position, even when these three essentials have no counterpart in nature.

FREDERICK EAST.

August, 1841.

ENGINEERING WORKS OF THE ANCIENTS, No. 8.

DIONYSIUS of Halicarnassus who lived in the time of Augustus, is the next author who contributes to our series, having extracted from his Roman Antiquities the following accounts of Roman works.

BRIDGE OVER THE TIBER.

Ancus Marcius, the 4th King of Rome (B. 3, ch. 14,) is said to have been the first who built over the Tiber the famous wooden bridge, which is considered as sacred. It must only be made of wood, and neither iron nor copper may be used in it. When any damage occurs it is the duty of the pontiffs to see to the repair, and to perform certain sacrifices prescribed by law during the progress of the works.

Ancus Marcius greatly enlarged the city of Rome, and built the port of Ostia at the mouth of the Tiber.

SEWERS.

TARQUINIUS PRISCUS, the 5th King (B. 3, ch. 20), built the walls of Rome of large squared stones, and commenced the sewers, by which the waters are collected in the streets of the city, and carried into the Tiber. The work is admirable, and beyond anything that can be said. For my own part, I believe that Rome has nothing more magnificent, nothing which better shows the grandeur of her empire, than her aqueducts, streets, paved roads, and sewers; I judge thus not only on account of their utility, but still more on account of the immense outlay which they have required. To prove what I assert, I will only instance the sewers. According to Caius Aquilius, having been for some time so neglected that they were stopped up, the censors concluded a bargain with a contractor to clean and repair them for a thousand talents.

We cannot pass over this tribute of the old historian without remarking that while the temples of Greece are scattered in ruins, and their proudest ornaments become the trophies of barbarians, the roads, aqueducts, and sewers of the Romans still minister to the wants of nations, centuries after the power of their founders has ceased to exist. The English emulate the Romans in the useful nature of their enterprises, and we trust that the labours of our engineers may minister as long to the service of the world as those of their predecessors.

GREAT CIRCUS.

Tarquin also embellished the Great Circus between the Aventine and Palatine mounts, and was the first who constructed around this circus covered seats, whereas the practice formerly was to place scaffolding around.

TARQUINIUS SUPERBUS.

Tarquin the Proud (B. 4, ch. 10,) the seventh and last king of Rome, employed the people on the public works in order to occupy them and prevent them from plotting. He continued to the Tiber the sewers begun by his grandfather, and carried out several of his unfinished works.

STRABO.

Having thus dismissed Dionysius of Halicarnassus, we come to Strabo, one of the most celebrated of the geographical writers of the ancients, and from whom, as from Diodorus Siculus, much information is to be gleaned as to ancient mining, a most important branch of engineering, as bearing upon earthworks. We shall first take the third book.

MINES IN SPAIN.

A chain of mountains, (the Sierra Morena), parallel to the Betis (Guadalquivir) extends towards the north, approaching more or less the banks of the river; it contains a great many mines. Silver is found every where in the neighbourhood of Ilipo and Old and New Sisapone (Almaden). Near the place called Cotinas, gold and copper are worked together. The mountains on the banks of the Anas (Guadiana) also contain mines.*

* B. 3. ch. 2.

From Turdetania is exported cinnabar equal to that of Sinope. There is also found fossil salt.*

What renders Turdetania particularly remarkable is its excellent mines. In fact all Iberia is full of them; but Turdetania unites all the advantages of a mining country to a degree which surpasses any praise. In no country in the world do we find gold, silver, copper and iron in such quantity or of similar quality. Gold is obtained not only from the mines but also from the rivers and streams, in which it is contained mixed with sand. It is also to be found in many dry places, but with this difference, that in these it cannot be distinguished at sight, whilst it shines when covered with the water. This is the reason why water is made to pass over sandy places, to make the particles of gold shine. Wells also are dug, and many means have been invented for separating the gold from the sand by washing, so that there are more gold washing works in the country than mines. The Gauls assert that their mines, as well those of the Cevennes as those of the Pyrenees situated on their side, are better; but, nevertheless, the mines on the Spanish side are generally more esteemed. Among the particles of gold are sometimes lumps of gold weighing half a pound, which are named *palcs*, and require very little refining. In cutting stones of ore, small lumps of this metal are sometimes found. After having roasted the gold intended to be purified, by means of an aluminous earth mixed with it, the result of the operation is the alloy of gold and silver known under the name of *electrum*. It is again placed in the fire, which separates the silver, and leaves the gold pure; for this latter metal is easily fused, and is not of much hardness. It is also fused sooner by the flame of straw, which, being milder, agrees better with the nature of gold, which obeys its action, and dissolves easily, while charcoal, being stronger, consumes a great part by liquefying it too soon, and converting it into vapour. As to the beds of rivers, the particles are extracted, washed in buckets, or in wells or holes made near, and the earth is washed. The furnaces for melting silver are generally made higher, to enable the pernicious vapour of this metal to rise and be dispersed. Some mines of copper have the name of gold mines, whence it is presumed that they formerly supplied this metal.

Posidonius, in speaking of the number and excellence of these mines, uses all the exaggerations of an enthusiast. The Turdetanians, says he, use the greatest industry and labour in digging winding galleries far into the earth, and often in draining, by means of Egyptian spirals, the subterranean streams with which they meet. But their lot, he observes, is very different from that of the miners of Attica, to whom may be applied the ancient enigma, "They have not taken all that they have drawn from the earth, and they have left there what they possessed." The Turdetanians, on the contrary, draw from their mines enormous profits, since the fourth of the earth which they extract from the copper mines is pure copper; and the silver mines furnish private individuals in three days with a quantity of this metal equivalent to a Euboic talent. As to tin, according to the account of Posidonius, it is not found on the surface of the earth, as some historians assert, but it is also extracted from mines. Mines of this metal are found among the barbarous people who inhabit beyond the Lusitanians and in the Cassiterrides Islands, and tin is also brought from the British islands to Marseilles. Among the Artabri, in Gallacia, the last people of Lusitania, on the north and west, there is earth covered with a dust of silver, tin, and of the metal, known under the name of white gold, on account of its alloy with silver. This dust is brought down by the rivers, raked up by the women, and then washed by them in sieves placed upon baskets. This is what Posidonius says as to the mines of Iberia.

Polybius, in speaking of those of silver which exist near New Carthage (Carthagena) says that they are 20 stades from the city, that they are so great that they extend over a district of 400 stades in circumference, that they habitually employ 40,000 workmen, whose labour brings to the Roman people 25,000 drachms per day (about £350,000 per annum). I do not enter into the detail of all the other operations, which would be too long, I confine myself to what Polybius says as to the manner in which the silver is treated, which is contained in the rivers and torrents. After having pounded and sifted it over water, what remains is separated from the water and pounded again; after having been sifted again, it is pounded and sifted five times in all. After this the pulverized matter is melted to separate the lead contained in it, and the silver remains pure. These mines of silver still exist, but there and elsewhere they belong to the state no longer, but have been taken possession of by private individuals; those of gold on the contrary mostly belong to the state. Here as well as at Castulon (Caslona) and in other places are mines of lead, which contain silver, but in too small quantity to defray the expense of separation.

* B. 3, ch. 2.

A little way from Castalon is the mountain whence the Betis (Guadalquivir) springs; it is named the Silver Mountain, on account of the mines of that metal which it contains.*

Lusitania is watered by great and small rivers which contain many grains of gold. Although the country abounds in gold, the inhabitants preferred living by plunder.†

The mountains in the neighbourhood of Malacca (Malaga) contain in several places mines of gold and other metals.

Not far from Dianium (Denia) are very fine forges.‡

WORKS IN SPAIN.

In the neighbourhood of Asta (Mesa de Asta), Nebrissa (Lebrisa), Onoba (Gibraleon), are canals dug in several places to facilitate the navigation.§

Near Cadiz is to be seen the Tower of Cæpio built on a rock, washed on every side by the sea. This admirable work was constructed in imitation of the Pharos of Alexandria.‖

SCILLY ISLANDS.

The inhabitants trade in the tin and lead which they dig from their mines. Publius Crassus, who went there, found that their mines are not very deep.

WORKS IN GAUL.

The extracts which follow are from various books.

Marius, perceiving that the mouth of the Rhone was becoming gradually shoaled up, had a new channel dug, which received the greater part of the waters. This canal he gave to the Marseillese in recompense for their service in the wars, and it became to them a great source of riches on account of the dues which they levied on those who went up or down.¶

The road from Iberia to Italy passes through Nimes. It is good enough in summer, but very bad in winter and spring, on account of the rivers overflowing and depositing mud. This road passes several rivers by boats, or by bridges of stone or wood.**

The territory of the Cevennes abounds with gold mines.††

The Tarbeili, a people of Aquitaine, are in possession of the most esteemed gold mines; for without digging deep, lumps of gold as big as the hand are sometimes found, requiring only a slight washing. The rest of the mine consists of grains and lumps, which do not either require much work.‡‡

BRITAIN.

Britain produces gold, silver, and iron.§§

LIPARI.

Lipari has very productive mines of alum.‖‖

ROMAN ROADS AND BRIDGES.

The Romans says Strabo, have principally employed themselves upon what the Greeks have neglected—I mean paved roads, aqueducts, and those sewers which drain the city of Rome. In fact, by cutting through mountains and filling up vallies, they have every where throughout the country made paved roads, which serve to convey from one place to another the goods brought by sea to the ports. The sewers of Rome, arched with dressed stone, are broad enough in some places for a cart laden with hay to pass; and the aqueducts bring water in such abundance as to form streams running across the city, cleansing the sewers, and are sufficient, as it may be said, to supply all the houses with great fountains, canals and reservoirs. This last advantage is principally owing to the cares of Marcus Agrippa, who has decorated Rome with many other public monuments.¶¶

The principal of the great roads which traverse the country are the Appian Way, the Latin way, and the Valerian Way.***

According to modern accounts, the Valerian way was about 100 miles long; for the first 15 miles are found ruins of bridges, causeways, &c. Beyond, the remains of it are not so evident, but the boldness with which it is carried across three mountain chains is surprising.

Near the city of Como, to master the people disposed to robbery, roads have been constructed, which are as practicable as it is possible for art to make them. Augustus, not content with clearing the roads of the banditti, has made them as convenient as possible, although the country is very difficult.†††

M. Emilius Scaurus constructed the Emilian Way running to Sabbata and Darthon; and there is another Emilian Way, which continues the Flaminian Way, and was the work of M. Emilius Lepidus, colleague of C. Flaminius* (This is an error of Strabo in attributing the Flaminian way to this Flaminius.)

* B. 3, ch. 2. † B. 3, ch. 3. ‡ B. 3. ch. 4
§ B. 3, ch. 2. ‖ B. 3, ch. 1. ¶ B. 4, ch. 1.
** Ib. †† Ib. ‡‡ B. 4, ch. 2. §§ B. 4, ch. 5. ‖‖ B. 6. ch. 4.
¶¶ B. 5, ch. 7. *** B. 5, ch. 7. ††† B. 4, ch. 6.

The Salarian Way is a great road very short.† To it joins the Nomentan Way.

The Appian Way is paved from Rome to Brundisium (Brindisi), and is the most frequented of all the roads made in Italy. Beyond Terracina on the Roman side, the Appian way is bordered by a canal, which receives the water of the marshes and rivers. It is particularly by night that this way of the canal is preferred; upon it people embark in the evening, and leave it in the morning, and take for the rest of the journey, the Appian Way, but even in the day-time the boats are towed by mules.‡

Near Baiæ is an isthmus of a few stades, through which a road is tunnelled. Near Naples is a similar one, which, in the space of several stades, crosses the mountain situated between Neapolis and Dicearchia. Its breadth is such that carriages which meet find no difficulty, and light is admitted by several openings pierced internally from the surface of the mountain through a great thickness.§

The Aternus (Pescara) in the country of the Peligni is passed by a bridge 24 stades from Corfinium.‖

CANALS.

The greater part of Transpadane Italy is full of lagunes, and therefore the inhabitants have made canals and dykes as in Lower Egypt, a part of the inundated ground being drained and the rest navigable.

Epiterpum, Concordia, Atria, Vicetia, and some other small places in the neighbourhood of Ravenna, by small navigable canals communicate with the sea.

The Cispadane was for a long time covered by marshes, which arose from the superabundance of the waters of the Po, but Scaurus, by having navigable canals dug from Placentia to Parma, drained the plain.

Ravenna is a great city built on piles in the midst of the marshes, and intersected with canals, which are crossed by boats or bridges.¶

DYKE.

The Locrine Gulf in its breadth extends as far as Baiæ, and is separated from the external sea, in a length of 8 stades by a dyke broad enough for a great waggon to pass. This dyke it is said is the work of Hercules; as in rough weather the waves flowed over it, so as to make it impassable for foot-passengers, Agrippa had it raised higher.**

TIMBER.

From Tyrrhenia (Tuscany) is obtained timber for building, of which is made very long and straight beams.

Pisa supplies timber for building much used by the Romans.††

CEMENT.

Dicearchia or Puteoli has become a place of great trade, on account of the works by which it is sheltered, having in the sand of the neighbourhood (puzzolana) great facilities for such constructions. This sand employed in a certain proportion with lime, makes a body, and becomes very solid.‡‡

MINES AND QUARRIES.

The Salassi have gold mines, the working of which was facilitated by the Durias (Doria) which supplied the water required for the washings; so that, by diverting the courses by numerous branches, they often dried up the main bed, which was the cause of constant war with the neighbouring people, whose agriculture was affected. The Salassi, although conquered by the Romans and dispossessed of their mines, being masters of the mountains, continued to sell water to the mine contractors.

Polybius relates that in his time among the Taurisci Norici, (people of Corinthia, Istria, &c.) were mines of gold so rich that by digging the ground only two feet deep gold was met with, and that the ordinary works were not more than fifteen feet deep; that a part was native gold, in grains the size of a bean or a lupine, which in the fire only diminished an eighth, and that the remainder, although requiring to be more purified still, gave a considerable product. [He adds] that the Italians having entered into agreements with the barbarians for working these mines, in the space of two months the price of gold fell throughout Italy a third, and that the Taurisci having perceived it, turned out their foreign colleagues, and sold the metal themselves. At the present day the Romans possess these mines. The rivers, also, like those of Iberia, contain grains of gold, although in smaller quantity.§§

Near Acyleia (Aquileia) are mines of gold and iron easy to work.‖‖

* B. 5, ch. 2. † B. 5, ch. 6. ‡ B. 5, ch. 7. § B. 5. ch. 10.
‖ B. 5. ch. 9. ¶ B. 5, ch. 2. ** B. 5, ch. 7. †† B. 5. ch. 4.
‡‡ B. 4, ch. 2. §§ B. 5, ch. 6. ‖‖ B. 5, ch. 2.

Cisalpine Gaul has mines which are not worked so much as they used to be, perhaps because they produce less than those of the Transalpine Celts and of Iberia, but formerly they were worked very much, since a mine of gold was wrought even in the territory of Vercelli.*

In the territory of Poplonium (Capo di Campana) are some abandoned mines, and the forges in which is wrought the iron of Elba, which, as it can only be reduced in the furnaces, is transported to the continent, as soon as it is brought out of the mine. Strabo says that the excavation of these mines grew up.†

Pithecusa (Procida) has gold mines.‡

Near Luna in Tyrrhenia are the quarries of marble, white, and spotted with green, of which tables and columns are made of a single block. These quarries are so numerous and so well supplied, that they are sufficient for most of the fine works which are made at Rome and throughout Italy.

The Pisan territory has an abundance of marbles.§

Gabii near Palestrina is in the midst of the quarries most used by the Romans.

At Tibura (Tivoli) are quarries of those different kinds of stones known under the names of Tiburtines, Gabians, red stones, of which most of the Roman buildings are constructed.‖

* B. 5, ch. 2. † B. 5, ch. 4.
‡ B. 5, ch. 2. § B. 5, ch. 4. ‖ B. 5, ch. 7.

ON THE FORMS AND PROPORTIONS OF STEAM VESSELS.

Sir,—Among the numerous opinions which have been advanced, as to the causes of the failure in point of speed which has attended the voyages of the British Queen and President, a subject to which the non-arrival of the latter vessel has given a most painful interest, I have not met with one which appears at all conclusive or satisfactory. Deficiency of power is always the first reason assigned; and a writer in a professional periodical, assuming that the models of these vessels are as perfect as any in existence, has gone the length of asserting that the power necessary to produce the same speed in vessels of similar form, but different dimensions, must increase in a larger ratio than the tonnage. His first position as to the forms of the vessels could, I think, be easily proved untenable, and his conclusion tends to subvert a plain physical principle; as he would make it appear that to overcome the resistance of the water, in which the *surface* of the immersed portion of the vessel alone is concerned, requires power increasing in a greater proportion than is requisite to conquer the inertia; the latter being always directly as the *mass*. Yet similar opinions are avowed by most persons who place reliance on the popular notions prevalent respecting the models of these steamers.—The nearest approach to the true manner of considering this question which I have yet seen, is, I think, made by a correspondent signing himself E., in the number of your Journal for last January; where he remarks that of the vessels he mentions, the best have the most beam in proportion to their length; and afterwards, that more seems to depend on model than power. Taking somewhat similar ground, I shall endeavour to show that as regards the several points of speed, capacity for carrying fuel to advantage, efficient working of the paddles, good qualities as seaboats, and power of carrying sail on an emergency; one essential requisite for seagoing steamers is a good breadth of beam in proportion both to their length and depth; and out of these considerations will arise others as respects the most advantageous modifications of form in the fore and after body. On all these points I shall confine myself, as much as possible, to such remarks as arise from known facts, my intention being merely to state opinions resulting from a good deal of observation, on a subject which I do not think has ever received the attention it deserves, from those more practically interested in it than myself. The first point to which I would call attention is that of speed. In all the comparisons which I have ever seen drawn as to the relative merits of different steam vessels, the principal data have always been the power of their engines, and the sectional area of the immersed parts of their bodies; and the comparison so far as regards the latter particular has always proceeded simply on the superficial area of these sections, no regard being paid to the increased pressure of the water with an increased depth: so that supposing two vessels have their immersed sectional surfaces parallelograms severally 40 feet wide by 15 feet deep, and 30 feet wide by 20 feet deep, these giving the same result as to area, their resistances are in the abstract considered equal, and any advantage which one such vessel may have in point of speed over the other, supposing their power, speed of engines, &c. to be equal, is always referred to some supposed superiority of form in the entrance and run of the faster vessel. Such a mode of calculation is founded, I believe, on the experiments of M. Bossüt, who gives as a rule that any plane surface moving with a given speed perpendicularly against a fluid, suffers a resistance equal to the weight of a column of the fluid, with a base equal to the area of the moving surface, and of such a height as a body must fall to acquire the given velocity. I have never seen the details of these experiments, nor do I know whether they are within my reach, but I feel pretty certain that the surfaces made use of must have been immersed in all cases the same depth in the fluid, and the difference of dimension must have been made in breadth only, or such results could never have been arrived at. Suppose the two above named surfaces were those of flood gates; to ascertain the pressure of water on each, 600 square feet, the common result of 40×15, and 30×20, must be multiplied into the pressure at the mean depth of each. The pressure of water at the depth of $7\frac{1}{2}$ feet, the mean of 15, may be taken as 3·75 lb. per square inch; and that at 10 feet, the mean of 20, as 5 lb. These numbers multiplied into 86400 the number of square inches in each surface give the results of 325000 lb. = 145 tons 1 cwt. 88 lb. for the first named, and 432000 lb. = 192 tons 17 cwt. 6 lb. for the second, being about as 7 to 9; and yet if the rule applied to calculate the resistances of vessels be correct, these two surfaces when put in motion at the same speed, immediately have their amounts of resistance equalized, because their areas are equal!—Such a result is manifestly absurd; and as the increased pressure of water in the proportion of its depth is an established fact, I shall proceed on these premises to inquire into the manner in which these vessels would be affected by the alteration of form necessary to reduce their resistance in moving through the water. We will suppose, for simplicity of argument, that their transverse sections are uniform throughout, and that both in plan and elevation they are also parallellograms: that they are each of the length of 200 feet, and their cubic contents consequently the same, viz., 120,000 feet.

Fig. 1.

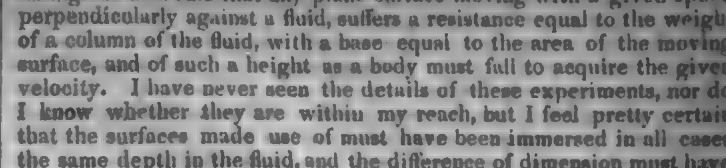


Fig. 2.

Suppose it were required to reduce their resistance by one half, preserving to the wider vessel her advantage of 7 to 9. Let fig. 1 represent the vessel of 40 feet beam, and fig. 2 that of 30. To effect the required reduction, we have simply to employ the principle of the wedge, and making *a b* in each figure equal to *c d*, in the same we have *b a*, the velocity of the vessel, equal to twice *b c*, the velocity of the weight which represents the resistance of the water to the motion of the vessel in the direction *b a*. For the weight or resistance of the whole surface *c d* is divided into two equal parts on the surfaces *a c*, *a d*, and these two halves being each moved the distance *b c* or *b d*, while the vessel moves the distance *a b*, a power is shown exactly equivalent to that of a wedge *c a e* in fig. 1. I state this thus fully because some writers on mechanics, as Emerson for example, make it appear that though the direction of the power be that of the line *a b*, it is to be calculated on the proportion which *c d* bears to *a b*, instead of that borne by *c b* or *b d*, the half of *c d*.

The vessels are thus reduced in their bulk or tonnage by the amount of a rectangular prism equal in its upper surface to the parallelogram *c b*, *b a*, and, (as we are at present considering only the immersed portion of their hulls,) of the immersed depths of each, viz., 15 feet in fig. 1, and 20 feet in fig. 2. Now *a b* is in each equal to the beam of the vessel, and *c b* equal to half *a b*, therefore the cubic contents of the parts removed are in fig. 1, $40 \times 20 \times 15 = 12{,}000$ cubic feet, and in fig. 2, $30 \times 15 \times 20 = 9000$ feet, giving a difference of 3000 feet, which divides exactly 40 times into 120,000, the total cubic contents of each vessel; thus by the sacrifice of $\frac{1}{40}$th part of the immersed portion of her body, we preserve to the vessel of greatest breadth her advantage in point of speed of 7 to 9, together with the

other good qualities which I shall hereafter show to attend her proportions, by the alteration of form in the horizontal direction alone. We have next to consider how the relative merits of the two vessels will stand if it be required to give the same speed to both with the same power. Their relative resistances being as 7 to 9, we will suppose that the velocity attained by the narrower vessel with a given power is sufficient for the wider; to reduce the latter to the speed of the former, we again have recourse to the principle of the wedge, by making *a b* bear the same proportion to *c d*, or 40 feet as 7 to 9. We thus find as 9 : 7 : : 40 : 31·11; then *b c* 20 × 15 (the depth) × 31·11 = 9333 cubic feet, the amount by which the bulk of the wider vessel is decreased to attain the same speed as the narrow one. But the latter was shown to lose only 9000 cubic feet of her bulk by this means, and she has still therefore an advantage of 333 feet over the wide vessel, 333 will divide about 360 times into 120,000, therefore the wide vessel sacrifices 1-360th part of her bulk more than the narrow one to attain the same speed by alteration of her horizontal form; but this amount is so small as to be quite inconsiderable, for in a vessel of 2000 tons burthen the difference will be but $3\frac{1}{18}$ tons.

Thus much as to the diminution of resistance by alteration of the horizontal form; let us now inquire how the same effect may be produced by altering the vessels in their vertical section. Let fig. 1* represent the vessel of 40 feet beam, and fig. 2* that of 80, in elevation, or longitudinal section. The depth *a b* equals 15 feet in fig. 1*, and 20 feet in fig. 2*. To reduce their respective resistances as before to one half, we make *b c* equal to twice *a b*, viz., 30 feet in fig. 1*, and 40 feet in fig. 2*. They are then reduced in bulk as follows: fig. 1* by 15 × 15 × 40 = 9000 cubic feet, and fig. 2* by 20 × 20 × 30 = 12,000 cubic feet, showing a difference of 3000 cubic feet in favour of fig. 1*, being exactly what was lost when reduced in her horizontal form to give the same results. Again, to reduce the speed of fig. 1* to that of fig. 2*, make *b c* : 30 : : 7 : 9, thus *b c* = 23·33 feet, and $\frac{23 \cdot 33}{2} \times 15 \times 40 = 6999$ cubic feet, making a difference in bulk of 5001 cubic feet in favour of fig. 1*, at the same velocity as fig 2*. Com-

Fig. 1*.

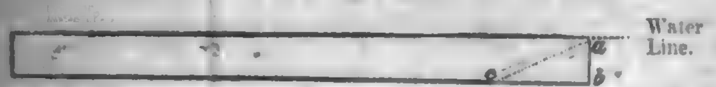


Fig. 2*.

paring these results we see that giving the wider vessel the same speed as the narrow one, she lost 333 cubic feet more of her bulk than the latter, by doing the same by change of form vertically she has an advantage of 5001 cubic feet.* As it is almost always necessary to employ both these methods of reducing a vessel's resistance, I shall suppose them equally applied, and deducting the loss from the gain we have still 4668 cubic feet of bulk remaining for buoyancy or stowage in favour of the wider vessel when the two have the same velocity; and as the loss in preserving her advantage of 7 to 9, by change of horizontal form exactly equalled her gain in doing so by the vertical alteration, if both means are equally employed we find she preserves her advantage in speed without any loss of bulk whatever beyond the narrow vessel, and, as I think can be proved, with many points of superiority in other respects. I have considered these effects as applied to bodies of simple parallelogramic forms in the first instance for the sake of simplicity of illustration, but the principle is applicable to all forms; and as regards vessels with sharp bottoms, and of a breadth of beam say equal to the wider vessel supposed above, and of a draught equal to the narrow one, their resistance may be resolved into that of parallelograms depending in their proportions of depth and width on the acuteness or obtuseness of the angle which their bottoms make at the keel, and on the depth of their bilge or union of the sides and bottom below the water line. I shall have occasion again to refer to this part of my subject when I come to speak of the comparative stability of vessels of different transverse sections. At present I shall only remark that the results of the above calculations are fully borne out by all the seagoing steamers I am acquainted with. For instance, the Gorgon and Cyclops of 1200 tons burthen and 320 horse power, having good beam, have performed excellently; while the Liverpool, in her first state of 1042 tons burthen, and 460 horse power, through great deficiency of beam, was a miserable failure; but since her alteration, though greatly increased in tonnage by the addition of 7 feet beam, she gives more satisfactory results with the same power than any of the large steamers built for crossing the Atlantic. The Great Western registering 1340 tons, and of 450 horse power, having pretty fair beam, was the only one of the New York steamers which could be said to answer, until the Liverpool was altered, since which time the latter seems to have the advantage. The British Queen and President have completely nullified the calculations of their projectors, and Mr. Cunard's steamers, almost equally deficient in this respect, employ about 500 horse power to do what, judging from past experience, the Gorgon* and Cyclops would in all probability easily effect with 320. I think these results, independently of others which, with your permission, I shall hereafter adduce, are sufficient to prove the fallacy of the almost universal belief among shipbuilders and others that narrow vessels are necessarily faster than those of greater beam. So strongly however is this opinion held, that I know that shipbuilders of considerable experience and ability have declared that no steamer should have beam in a larger proportion to her length than as 2 to 13; or in other words should have no less than $6\frac{1}{2}$ breadths to her length; a proportion which has proved insufficient in most of the points which I named as necessary for a seagoing steamer: and for the sake of this dogma though sometimes giving their vessels very good horizontal lines, they sacrifice all the advantages they might obtain by a proper application of the reduction of body vertically, and are obliged from their want of beam, to trust to the enlargement of their bows above water to prevent their constantly shipping water forward, involving defects which I shall endeavour to make clear if I continue the subject. The subject of long narrow steamers of small draught in proportion to their beam, which have had many advocates, will occupy another part of our consideration, and I refer to it here merely to say that it is not overlooked. I believe the late system of computing tonnage for shipping has had a great share in producing the defect in point of beam which is to be observed both in our sailing merchant vessels and in our mercantile steamers; for in consequence of the gross absurdity of assuming a fixed proportion of depth for every vessel, namely, half of their measured breadth, and 94 as the divisor for reducing the cubic result of the three dimensions to tons, however different in form the vessels might really be. Merchants and shipbuilders universally endeavoured to gain as much as possible on their registered tonnage, by giving depth beyond the imaginary standard, and a form fore and aft which should give an absolute amount of bulk much above the $\frac{1}{10}$ths of the parallelogramic solid which were supposed, by the use of 94 as a divisor, to remain after reducing the vessel by the sharpening of her bottom, entrance, and run. This style of building has been frequently carried, as too many fatal instances have proved, far beyond the limits of safety, while vessels of really good proportions and fine form being registered by this method of a much greater tonnage than their real burthen, had an absolute fine in the shape of duty imposed on their good qualities.—In the fruit trade and others especially requiring speed, this has led to the building of deep narrow vessels sharp forward, and lean and hollow abaft, gaining somewhat in tonnage, but wanting in all really good qualities, being the wettest and most uneasy vessels which leave our ports. The numerous beautiful models which have fallen into the hands of our merchants as slave prizes have for the same reason, almost without exception, been lengthened and raised upon, have had all their fine points destroyed, been greatly reduced in speed, and frequently become exceedingly unsafe vessels, as was the case with a most beautiful slave schooner sold for the turtle trade in this port a few years ago, which having been raised upon, lengthened, and square rigged, went to the bottom on her second voyage. Since the passing of the New Tonnage Act, which assigns as nearly as possible the real contents of a vessel for her register, it might have been expected that some improvement would have taken place in the models leaving the stocks in our merchant builders' yards, but so strong is habit, especially bad habit, and so rooted is prejudice, particularly in matters where expediency and not principle has been the ruling power, that hardly any use has been made of the advantages offered by the new act, and our

* The American river steamers referred to in the conversation at the Civil Engineer's Institution on Mr. Seaward's table of velocities, are described as diminished principally in the vertical direction; they have been aptly described as having "spoon entrances."

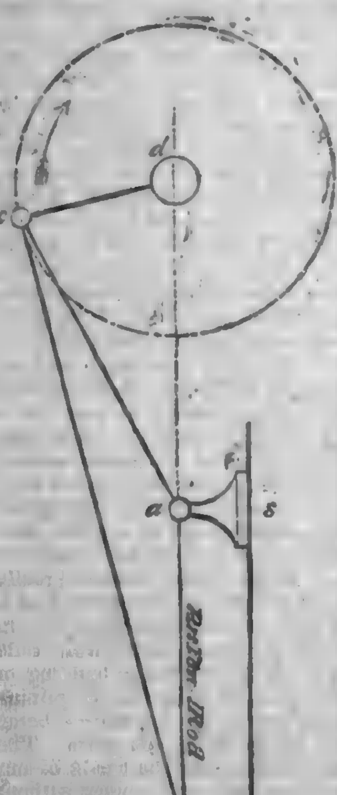
† See C. E. and A. Journal, vol. 1, p. 385.

newly built merchant ships, in general, present no more satisfactory aspects than their predecessors; and the proportions published as those of the new steamers building in Scotland for Government, are a further illustration of this position.† Unfortunately this defect has influenced the docks intended for the reception of merchant steamers, and unless the gates of those in this port were increased in width they would not admit steamers of the same tonnage as those now using them, but of greater beam.—Having trespassed at so great length on your space, I beg to observe in conclusion, that my reason for having cited no authority in support of my views is simply that I have met with none taking the same ground; and of those treating on this subject under any aspect, the older ones are generally very vague and general in their statements; and the more modern, though entering at great length and with much pains into particular forms, are so partial in their manner of considering the matter, that of the two whose opinions have latterly carried most weight, I have found one advocating the construction of seagoing steamers twelve times as long as they are broad, and the other predicting the time when masts and sails would be considered mere useless incumbrances, and our line-of-battle ships be used only as coal transports for steamers. Such ideas indicate any thing but a comprehensive mode of viewing this subject, and not trusting much to the assistance to be derived from such sources I have preferred merely stating the result of my own observations, relying on the candid consideration of those who are practically interested in this matter.

I am, &c.,

H. P. H.

ON LONG AND SHORT CONNECTING RODS.



Sir—Perceiving in your excellent Journal for this month, an article respecting long and short connecting rods, wherein it is stated that the short connecting rod is as effective as the long one, I take leave to send you a diagram, which will perhaps show that there is a greater amount of friction with the short connecting rod.

The accompanying figure represents the direct connection with the piston of a long and short connecting rod. In this case it is clear that the long rod *c, b*, is working always nearer the *parallel line* of the piston than the short rod *c, a*, or that the short rod is pushing against the slide *s, e*, at a much greater angle than the long one, and consequently that there must be less friction at *e*, than at *s*, therefore as the angle *c, a, d*, is greater than the angle *c, b, d*, so is the friction at *s*, greater than the friction at *e*. The same results will be found with common marine and all other engines, only that where slides are used there is always a much greater amount of friction than upon centres. I am however of opinion, that a short connecting rod, with a direct connection with the crank, might be used with greater effect than a longer one in the common marine engine, where heavy side levers are kept continually reversing their motion, besides the extra weight which the boat has to carry.

I am, Sir, your most obedient servant,

J. F.

London, July 12.

Sir—In your July number you have a letter from Mr. Daniel Clark on "Long and short connecting rods," in which he arrives at the conclusion that "upon the whole, then, short and long connecting rods on the same length of crank must be equally effective, whatever peculiarities there be." In this, however, I do not concur with him and would recommend him to re-consider the subject and see if really the force (see Mr. Clark's first figure) D C or E M be of no consequence; I think he will find it to be of the greatest consequence, and to be together with the analogous force of pressure on the other journals, the reason why long connecting rods always have been and always will be preferable, and why, moreover, an engine, the connecting rod of which bears to the length of the crank a ratio less than a certain quantity, would not work at all. Mr. Clark would find it very interesting to consider minutely the case in which the length of the connecting rod is equal to the length of the crank, he will find that the strength required for the paddle-shaft, the connecting rod, all the journals, the framing, and in fact the whole engine, is what may probably startle him.

I am, Sir,

Your obedient servant,

J. G. L.

Greenock, July 5.

MR. PARKES NEW THEORY OF THE PERCUSSIVE ACTION OF STEAM.

Sir—Feeling some interest in Mr. Parkes' new theory of the percussive action of steam in the Cornish engines, might I offer a few remarks on the former part of a paper which appeared in your Journal for this month. The writer of that paper appears from his remarks at the beginning, to have an opinion that Mr. Parkes has rather favoured the Cornish engines, in considering that the percussive force of steam is only developed in them; and he remarks that if such a property does exist in the steam, we might expect to find it more fully developed in the case of the locomotive engines; for he says, "though why he considers it to operate in these engines only, we know not; we are of opinion that if it obtains in them, it should obtain *à fortiori* in locomotives, where the density and velocity of the steam entering the cylinder are so much greater."

The object of the following remarks is to try to show that the Cornish single-acting engines are the only ones at present in which the percussive force of steam could act with any very great advantage; and that the locomotives are the very worst engines in which it could be used as a moving force.

We will first of all take the case of a common double-acting rotative engine. In these engines the slide is so adjusted as to let the steam into the cylinder when the piston is either at the top or bottom of its stroke; and consequently, when the crank is just passing the centre. Now this being the case, it is evident that any percussive force of the steam striking upon the piston would be injurious rather than benefit the engine, as it could not by any means have any effect in turning the crank, but, on the contrary, only create an additional wear and tear of the different working parts, on account of the violent jerk which would be the effect of its striking upon the piston while the crank is in such a position as not to let it recede before the blow. In this engine, then, as at present constructed, we must not expect to find any very great economy by bringing this force into action.

In consequence of the rapidity with which the strokes of the piston in a locomotive follow one another, it is found necessary to admit the steam into the cylinder before the piston has finished its stroke, for two reasons: 1st, it is found necessary to admit the steam into the opposite side of the piston before it has finished its stroke, in order to bring it gradually up to the stop, and to diminish the violent jerk that would be occasioned by its motion being so rapidly changed, and 2ndly, so that it may be ready to act as soon as the piston has finished its stroke. This being the case, the percussive force of steam would act still worse here than in the before-mentioned case, as it would, instead of helping to impel the piston, actually impede it, if not stop it altogether. In this case, as well as in the former, the percussive action is altogether avoided by the gradual motion of the slide, for as soon as the slide begins to open the steam way, the steam rushes into the cylinder and strikes upon the piston, but with very little effect, on account of its being so much wire drawn in consequence of the small size of the opening at first.

In order to render the percussive force of steam available to its fullest extent as a moving power in single acting pumping engines, it would be necessary to have some medium interposed between the direct action of the steam on the piston and the pumps; so as to convert the ever-varying pressure on the piston into a regular and steady pressure on the plunger of the pump. This I think will be clearly seen, for if we suppose for an instant this medium not to exist, such as

† The Forth has lately arrived in Liverpool, and fully confirms the above opinion; proving with two steamers lately sent hither from Hamburg, that the examples of the Liverpool, British Queen and President have not influenced their builders in assigning the proportions of breadth and depth.

the momentum of the different parts of the engine, the pump rod, and the column of water set in motion; we must come to the conclusion that as the pressure on the piston varies without any medium to equalize its effect, the resistance opposed to the pump plunger ought to vary also.

In the common single acting pumping engine this medium is in a measure supplied by the weight of the pump rod, which is made sufficiently heavy to overcome the friction of the engine, and to raise the piston at the return stroke, and by the momentum of the beam and other parts of the engine; and also by the momentum of the column of water before it enters into the air vessel; these however would form but a very small reservoir for the immense pressure at the commencement of the stroke, so that in these engines the application of the percussive force must be very limited, in consequence of the pump rod not being of a sufficient weight to accumulate all the overplus power at the commencement of the stroke, so as to impart it to the plunger when the pressure on the piston, in consequence of the expansion of the steam, falls below the resistance on the plunger so that the percussive force would be in a great measure entirely wasted. Again on the other hand, if the rod which generally weighs from 8 to 9 tons, were made heavier, so as to equalize to a great extent the pressure on the plunger, it would be more than necessary to overcome the resistance of the engine at the return stroke, and so occasion a loss of power.

The action of the Cornish single acting engine is somewhat different from that of the common one, the pressure of the steam on the piston instead of being applied directly to work the pumps, is applied to raise a pump rod of sufficient weight to work the pumps at the return stroke. The result of this difference of arrangement is that instead of having a pump rod of 8 or 9 tons weight, we get one of from 20 to 70 tons weight according to circumstances. Here then we get an immense mass of matter amply sufficient to accumulate all the overplus power at the commencement of the stroke, and to return it as required at the end of it. The action of it is this: the steam being admitted suddenly into the cylinder strikes upon the piston at rest with a considerable force above what is due to its elastic pressure alone, and sets this massive pump rod in motion; the steam in the cylinder expands, and consequently acts with less force on the piston, and the pump rod after the pressure of the steam on the piston, becomes insufficient of itself to raise it any higher, assists to carry itself through the remainder of the stroke, by means of the power that it accumulated at the commencement. When the rod is thus as it were thrown up to the top of its stroke, the equilibrium valve is opened and the weight of the pump rod descending acts upon the plunger of the pump and raises the water. In this engine then we have the means of applying the percussive force of steam to almost any extent in consequence of the weight of the pump rod, which acts as a reservoir for the power that would otherwise be wasted.

These remarks I think have clearly shown that in the common double acting engine the percussive force of steam could not be made to act with any advantage, but would, on the contrary, occasion an additional wear and tear; that in the locomotive it would act still worse, and would actually impede the engine, if not stop it altogether; that in the common single acting pumping engine it could only be brought into useful action in a small degree; and that in the Cornish engine we might use it as a moving force to a very considerable extent.

When we consider the amazing quantity of work done by the Cornish engines as compared to any other, we are perfectly at a loss to account for the difference, and are brought to the conclusion that there must be some force in the steam which can only be applied to any considerable extent in those engines, and which will not allow of being so applied in any others. The elastic force of steam can be applied in any sort of engine, the expansive force can be applied economically in all, but more so in the Cornish than any other engines; but still this is insufficient to account for the difference of the amount of duty done. The only other force that we can conceive the steam to possess is that which Mr. Parkes has denominated its percussive force. If the conclusion drawn from the preceding remarks be just, we see that the Cornish engines are the only ones in which this force could be applied to any considerable extent.

It also stands to reason that if this force does exist in the steam, and if it was usefully applied it would increase very considerably the duty done. It is also now a fact well ascertained that the Cornish engines will do three times the duty of any other with the same expenditure of fuel.

Is it not then reasonable to infer that as the Cornish engines are the only ones in which the percussive action could be employed to any considerable extent, and that they alone perform that additional work that would be the effect of this force if usefully applied, we may safely conclude (if all other evidence was wanting), that this percussive force does actually exist in the steam, and that it in a great measure will account for the quantity of work done by these engines.

Hoping that these observations may help to throw a little light on the subject, and may induce some of your readers who may have the means, to pay a little attention to the subject.

I remain, Sir, your's, respectfully,

C. S.

Bankside, Southwark;
August 13, 1841.

ON THE MOMENTUM PROPOSED BY MR. JOSIAH PARKES, AS A MEASURE OF THE MECHANICAL EFFECT OF LOCOMOTIVE ENGINES.

By the Count De Pambour.

In the *Transactions of the Institution of Civil Engineers*, vol. III, Mr. J. Parkes has published a paper *On Steam-boilers and Steam-engines*, in which the object s to propose, as a new measure of the mechanical effect of locomotive engines, what he calls the *momentum* produced by the engine, that is to say the product of the mass, in tons, of the engine, tender and train, multiplied into its velocity, in feet per second. According to him, this momentum being measured at one velocity, for a given engine, the effect of the same engine, at any other velocity, will be immediately deduced from it by a single proportion (page 130), without troubling one's head about the inclination of the road, the friction of the wagons or the engine, the counter-pressure due to the blast-pipe, the resistance of the air, or, in fact, any of the resistances really encountered by the engines.

To establish this new idea, Mr. Parkes' first step is to represent as altogether faulty and impossible every calculation or experiment made by others, to take account of the divers resistances offered to the motion of the engines. With this view he enters into a long and malevolent discussion on the experiments of our *Treatise on Locomotive Engines*, and on all the experiments on the same subject published by different engineers; and to demonstrate the difficulties insurmountable, in his opinion (page 124, 129), and the uncertainty attending such researches, he indicates several verifications which, as he says, these experiments ought to satisfy, and which they do not satisfy. As Mr. Parkes gives on the subject a great number of arithmetical calculations, the errors of which are protected against detection by the heap of figures presented, we shall first enter, with some detail, into the examination of his pretended verifications, and afterwards shall discuss the value of the new measure proposed by him to represent the mechanical effect of locomotive engines.

On seeing the *fundamental* errors on which his reasoning and his calculations are grounded, the inaccuracy of his criticisms and of the results at which he has arrived, will be at once recognised.

1st. Mr. Parkes proposes to calculate the pressure at which the steam was necessarily expended on the cylinder of each engine submitted to experiment, in order afterwards to compare that pressure with the pressure resulting from the sum of the different determinations of resistances exerted against the piston, according to the *treatise on locomotive engines*. With this view, he seeks, from the velocity of the engine, the number of cylinders full of steam which were expended per minute. Comparing the volume thus obtained to the volume of water vaporized in the boiler, he concludes the *relative* volume of the steam during its passage into the cylinder; and finally, recurring to the table of the relative volumes of steam under divers pressures, contained in our *Theory of the Steam Engine*, he concludes the pressure which the steam must necessarily have had (page 82, &c.) This is conformable to our theory developed in the *Treatise on Locomotive Engines*, which, in fact, Mr. Parkes entirely adopts. But to perform this calculation, Mr. Parkes takes the *average* velocity of the whole trip from Liverpool to Manchester (page 85, and table viii., col. 10; table xiii., col. 9; table xvi., col. 2, &c.), and from that velocity he pretends to deduce the *mean pressure* of the steam in the cylinder during the same trip. Now it will be easy to prove by an example that this mode is altogether faulty.

Suppose, in effect, the engine Atlas has travelled a distance of 30 miles in an hour and a half, vaporizing 60 cubic feet of water per hour. As the wheel of the engine is 5 feet in diameter, or 15·71 in circumference, as there are two double cylinders-full of steam expended at every turn of the wheel, and as the capacity of those two double cylinders, including the filling up of the steam ways, amounts to 4·398 cubic feet, it follows that the volume of the steam which passes into the cylinders per mile performed, or per distance of 5280 feet, is

$$\frac{5280}{15{\cdot}71} \times 4{\cdot}398 = 1478 \text{ cubic feet.}$$

This premised, when Mr. Parkes refers to the average velocity of the whole trip, to value the pressure in the cylinder, as that velocity is 20 miles per hour, and as the vaporization at the same time is 60 cubic feet of water per hour, he finds, for the ratio of the volume of the steam expended to the volume of water, $\frac{1478 \times 20}{60} = 492{\cdot}7$. Consequently, recurring to the table of the relative volumes of steam under different pressures, he obtains for the corresponding total or absolute pressure 56·66 lb. per square inch; and deducting the atmospheric pressure, he obtains for the effective pressure, 41·95 lb. per square inch.

But to show that this mode of calculating, from the average velocity, can only lead to error, let us suppose that, by reason of the divers inclinations of the portions of the railway, the first 15 miles have been traversed in half an hour, and the other 15 miles in an hour, which still makes 30 miles in an hour and a half; as 30 cubic feet of water will have been vaporized in the first half hour, or during the passage of the first 15 miles, and 60 cubic feet of water during the next hour, or in the passage of the last 15 miles, it is plain that the volume of the steam will have been respectively in each of those times $\frac{1478 \times 15}{30} = 739$ first, and afterwards $\frac{1478 \times 15}{60} = 369{\cdot}5$. Whence results, according to the table, that the effective pressure of the steam will have been successively 21·62 and 62·95 lb. per square inch.

Thus, during the first half hour the effective pressure will have been 21·62 lb.; during the second half hour it will have been 62·95 lb., and during the third again 62·95 lb. Consequently, taking account of the time during which the pressure has had these respective values, it is plain that the mean effective pressure in the cylinder will really have been $\frac{21{\cdot}62 + 62{\cdot}95 + 62{\cdot}95}{3} = 49{\cdot}17$ lb. per square inch, and not 41·95 lb. per square inch, as given in Mr. Parkes's calculation; which, by the fact, supposes all the portions of the trip to have been performed in equal times. In this case, therefore, which has nothing in it but what is very ordinary, there would be an error of 7·22 lb. per square inch out of 41·95; that is an error of more than $\frac{1}{6}$ on the effective pressure of the steam. It is evident that the calculation, such as Mr. Parkes makes it, is exact only for portions of road composed of one inclination, or travelled with *uniform* velocity, and that it cannot apply to the total passage of a line composed of different inclinations. For further elucidation on this head, we refer to chapter XVII., relative to inclined planes, of our *Treatise on Locomotive Engines*, 2nd edition, and to chapter XII. of the same work, in which all the experiments considered by Mr. Parkes are calculated.

2nd. We have just shown the first error which Mr. Parkes introduces, as a fundamental basis, in his calculation of the pressure of the steam in the cylinder. But he does not stop there. In the table of experiments on the vaporization of the engines (*Treatise on Locomotive Engines*, page 175 of first edition, and page 253 of second edition), we have given the average velocity of the engines during each trip; and that velocity is obtained simply by dividing the whole distance performed, by the time employed in performing it, as is seen in the table in question. It would be natural then for Mr. Parkes, who, as has been said, is satisfied with average velocities in his calculations, to take those which are given in the table; but instead of that, he augments almost all the velocities about $\frac{1}{6}$. Thus, for instance, the VULCAN, which travelled 29·5 miles in 1 hour 17 minutes, and whose average velocity in consequence was stated to be 22·99 miles per hour, had, according to Mr. Parkes, a velocity of 26·90 miles per hour. The velocity of the VESTA rises from 27·23 to 31·60 miles per hour, and so of the others (table viii., col. 10; table xiii., col. 9; table xvi., col. 2). The critic falls into this new error because, in the *Treatise on Locomotive Engines* (page 324 first edition, and page 311 second edition), in speaking of fuel, it is said that, when the engines ascend without help the inclined planes of the Liverpool and Manchester Railway, the surplus of work, thence resulting for them, equals, on an average, the conveying of their load to $\frac{1}{6}$ more distance, and Mr. Parkes logically concludes from this that the *velocity* of the engine must be by so much increased (pages 86, 112). So that if an engine perform 1 mile in 4 minutes, ascending a plane inclined $\frac{1}{96}$, which renders nearly five-fold the work of the engine, it would follow, from this calculation, that the velocity would not have been 15 miles per hour, but $15 \times 5 = 75$ miles per hour, since the quantity of work done would have been five-fold! Mr. Parkes's error proceeds from his having applied to the velocity a correction which refers only to the *work* done, and, as a consequence, to the corresponding consumption of *fuel*.

But on examining what effect results from this substitution of the imagined velocity of Mr. Parkes for the observed velocity, it will be remarked that whenever an engine is obliged to ascend without help one of the inclined planes of the Liverpool and Manchester Railway, it exerts at that moment, as we have said, an effort five times as great as upon a level, and draws its load less rapidly. One would deem it then allowable to conclude, that the average pressure of the steam in the cylinder must be augmented, since during a certain portion of the trip, the effort required is greater, and that the *useful* effect per unit of time must be diminished, since during the same time the useful load is drawn at less velocity. But no. Mr. Parkes's calculation, by augmenting, then, the apparent velocity of the engine, demonstrates that, in this case, the average pressure in the cylinder becomes on the contrary much *less*, and that the useful effect becomes much *greater*. So that the error committed produces itself here in the two opposite ways.

With these elements Mr. Parkes establishes the *whole* of his calculations and tables, to the very end of his paper (table viii., col. 10; table ix., col. 19; table xiii., col. 9; table xiv., col. 2; table xvi., col. 2); and as, to augment the evil, this pretended correction is made only on one portion of the experiments, namely those in which the engines were helped up the inclined planes, without being made in the other cases, there results an inexplicable confusion in all the calculations. Thus, it happens that Mr. Parkes's determination of the volume and pressure of the steam consumed by the engines (table ix., col. 26, 29), the horse power produced per cubic foot of water vaporized, or the quantity of water employed to produce one horse power (table x., col. 44, 45, 49, &c.), the momentum generated per pound (table xiii., col. 11, 12; table xiv., col. 9, 10, 11), and all the consequences thence derived are in every way erroneous.

To show by a particular example, the fallacy of the results to which Mr. Parkes has been led by this wholesale and faulty way of calculating, we need only refer to the two experiments of the FURY, which he extracts from our work on locomotive engines. He pronounces, "with certainty," (page 128), these two experiments to be erroneous, as exhibiting an engine performing more work at 23 than at 21¾ miles per hour, in the ratio of 24 to 19. Now, to arrive at this conclusion, Mr. Parkes first takes the velocity of the engine, not at 18·63 and 19·67 miles per hour, as given from actual observation, page 175 of the first edition, and pages 253 and 392 of the second edition of our Treatise on Locomotive Engines, but at 21·79 and 23 miles per hour (table xiii., col. 3). Secondly, in comparing the work done in the two trips, he does not take into account that the first of the two trips has been made from Manchester to Liverpool, and the second on the contrary from Liverpool to Manchester. But there is a general rise of the ground from Manchester towards Liverpool, and from that circumstance, the gravity opposes more resistance in that direction than in the contrary one. Thus it happens that a less train carried on the line from Manchester to Liverpool, may require from the engine, a greater quantity of labour than a heavier train carried in the opposite way. In effect, by referring to pages 501 and 504 of the second edition of our work on locomotives, it will be found that in the two experiments under consideration, the work done by the FURY, in carrying the two loads of 43·8 and 51·16 tons, besides tender, from Manchester and from Liverpool respectively, to the other end of the line, was

43·8 tons, from Manchester to Liverpool, equal, gravity included, to - - - 1964 tons to 1 mile.
51·16 tons, from Liverpool to Manchester, equal, gravity included, to - - - 1837 tons to 1 mile.

We see, therefore, that when we take an account, as we ought to do, and as Mr. Parkes has not done, of the surplus of labour caused by gravity, the work required of the engine is in reality more in the first case than in the second, although the load itself is less. Consequently the engine ought to have accomplished the second trip in less time or with a greater average velocity than the first, which in fact it did, and which had led Mr. Parkes to pronounce with such "certainty" the experiments to be erroneous.

This example shows that the calculation of Mr. Parkes, made with an erroneously averaged and exaggerated velocity, in which, moreover, he omits the gravity on the inclined planes, the resistance of the air, the friction of the engine, and all the other resistances really opposed to the motion, leads him to a *very inaccurate* measure of the work performed by those engines; and this refers to the whole of the results obtained, table ix., col. 29—32; table x., col. 41—50; table xiii., col. 11, 12; table xiv., col. 9, 10, 11; table xvi., &c., and also to his comparison of locomotive and stationary steam engines, which we shall notice further on.

3rd. After having calculated *very exactly*, as we have shown, the pressure of the steam in the cylinder, Mr. Parkes compares the result which he has obtained, with the total pressure on the piston resulting

from the partial resistances suffered by the engine, according to the *Treatise on Locomotive Engines*; and as, in the first edition of that work, the author had confined himself to mentioning the pressure against the piston due to the action of the blast-pipe, without making any experimental research on the subject, Mr. Parkes, without noticing the results presented since in the *theory of the steam engine*, (page 161), takes the difference between the two results, as necessarily expressing the pressure due to the blast-pipe (pages 82, 83); and he demonstrates the inaccuracy of it. Here we perfectly agree with him; for, besides the errors already pointed out in his research of the pressure of the steam in the cylinder, every thing variable that can occur in the different data of resistance, now passes to the account of the pressure due to the blast-pipe, and must necessarily come to falsify the calculation of it. Thus, for instance, in the experiments, a great deal of water was lost by *priming*, and there resulted an apparent vaporization greater than the true one. A part of the difference between the calculated and the observed pressure was therefore to be attributed to that cause, though it could not be accurately measured; but, by the calculation of Mr. Parkes, it all passes to the account of the pressure due to the blast-pipe. Similarly, the resistance of the air, then imperfectly computed in the total resistance for an average velocity of about 12 miles per hour, is found, in all cases of greater velocity, to augment considerably the pressure due to the blast-pipe, and on the contrary to diminish it in all cases of less velocity. A favourable or an unfavourable wind necessarily produce similar effects. Thus, circumstances, combined with the fundamental errors already introduced in the calculation, raise or lower that pressure to all imaginable degrees (pages 87, 88, 90, 91); and it will be readily imagined that such a determination cannot be exact.

4th. Mr. Parkes has observed, in the experiments of the *Treatise on Locomotive Engines*, and particularly in two of them, made with the LEEDS engine, and quoted in the *Theory of the Steam Engine*, that the useful effects produced by the same quantity of water vaporized varies according to different circumstances, and he is amazed at it; for, as he affirms, the useful effects produced by the same quantity of water vaporized, in the same time and under the same pressure in the boiler, ought in all cases to be identical (pages 104, 119). But this again is merely an error of the critic; for if we suppose a locomotive engine drawing a heavy load at a small velocity, since it is only at a small velocity that the engine has to overcome its friction, as well as the atmospheric pressure against the piston, and, above all, the resistance of the air against the train, it follows that out of the quantity of total work executed, there will be but a trifling portion lost in overcoming those resistances; but if, on the contrary, we suppose the same engine performing precisely the same quantity of *total* work, but drawing a light load at a great velocity, it is obvious that a much greater part of the work done will be absorbed in moving, at that velocity, the resistance which represents the friction of the engine, as well as the atmospheric pressure against the piston, and in overcoming the resistance of the air, which increases as the square of the velocity; and consequently there will remain a much smaller portion of it applied to the producing of the useful effect. Hence, in the two cases considered, the useful effects produced by the same quantity of water vaporized, so far from being identical, will, on the contrary, be very different from each other. Mr. Parkes may, besides, satisfy himself on this point, by perusing the *Theory of the Steam Engine*, in which he will find numerous examples of steam engines, in which the useful effect of one cubic foot of water varies in very wide limits, according to the velocity of the motion or the load imposed on the engine; and he will find it explained theoretically in chapter XII. of the *Treatise on Locomotive Engines*, or in chapter III. art. 11, of the *Theory of the Steam Engine*. Thus Mr. Parkes's reasoning errs again by the basis itself.

5th. But there is another principle to which Mr. Parkes would subject all the observations of vaporization of locomotive engines. He remarks that in the two experiments above cited, the total resistance opposed to the motion is different in the two cases. Consequently, says he, the quantities of water vaporized by the engine in the same time must be in proportion to the pressures in the cylinder, and the experiments ought to satisfy this condition (pages 99, 100). Upon this point he is merciless.

To establish this new principle, Mr. Parkes recurs to the *Treatise on Locomotive Engines* itself. He quotes a passage in which, supposing same engine travelling the same distance with two different loads, the author says positively that the distance travelled being the same in both cases, the number of turns of the wheel, and consequently the number of strokes of the piston given by the engine, that is to say, the number of cylinders full of steam, or finally the total volume of steam expended, will also be the same in both cases; whence results that the same volume will successively have been filled with two steams at different pressures, or in other words, at different densities; and consequently the quantities of water which have served to form those steams will be in proportion to their respective pressures (page 310—312 of the first edition). Thus, this passage establishes very distinctly that the quantities of water vaporized, *for the same distance*, are in proportion to the pressures of the steam in the cylinders. But what does Mr. Parkes conclude from this? Why, that the quantities of water vaporized *in the same distance* are in proportion to the pressures in the cylinder. Now it happens to be just the contrary; for, if we suppose, by way of example, the two pressures to be in the ratio of 2 to 1, the volumes of water vaporized for the same distance traversed, will also be in the ratio of 2 to 1; but if the time employed in performing the distance in question be two hours in the first case, and one hour in the second, it is plainly the quantities of water vaporized in two hours and in one hour respectively, which will be one to the other in the ratio of 2 to 1, so that the vaporizations per hour, or *in the same time*, will be equal instead of being in the ratio of the pressures. Thus it is clear again that Mr. Parkes's principle rests but on a new error, which consists in making a confusion between the vaporization for the same distance and the vaporization for the same time.

6th. A final observation of Mr. Parkes (pages 89, 90, 98), is this, that in some experiments, the locomotive engines produced, for the same quantity of water vaporized, a greater useful effect than several stationary high-pressure steam engines, or even than several condensing steam engines; and he considers this result as a proof of the inaccuracy of those observations; for, says he, the locomotive engines having to contend with the pressure arising from the blast-pipe, which the high pressure engines have not, and also with the atmospheric pressure, neither of which resistances the condensing engines have to contend with, it is incontestable that they cannot even produce equal effects, much less superior ones (page 104). But this reasoning is as unfounded as those we have already noticed; for, since the useful effect of steam engines, for the same vaporization, diminishes as the velocity of the motion increases, which has been already explained above, and which is found developed, either in chapter XII. article II. of the *Treatise on Locomotive Engines*, second edition, or in chapter III. article II., section 1, of the *Theory of the Steam Engine*, it is easy to conceive that a locomotive working, for instance, at its maximum useful effect, that is to say, with its maximum load, and consequently at a very small velocity, at which the pressure due to the blast-pipe and the resistance of the air are nearly null, can produce a useful effect greater, nay much greater than a stationary high pressure engine, working on the contrary with a light load and a great velocity. The same inferiority of effect may also occur in a condensing engine, because an engine of that system working, for instance, at 16 lb. pressure per square inch in the cylinder, and condensing the steam to 4 lb. per square inch *under the piston*, where the pressure is always greater than in the condenser, loses, by that fact alone, a quarter of the power which it applies; whereas a locomotive, working at 5 atmospheres in the cylinder, and at a very small velocity, which renders almost null the pressure due to the blast-pipe, suffers, by the opposition of the atmospheric pressure, a loss equal to only $\frac{1}{5}$ of its total power. Hence, definitively, in the latter engine, the counter-pressure against the piston destroys a smaller portion of the total power applied, and consequently, without even noticing the difference of friction of the two engines, or entering into any other consideration relative to the velocity, it is conceivable that the useful effect of the locomotive may be found greater.

But if a more complete calculation be desired, it will be easy to furnish it; for the relative volume of the steam at 16 lb. pressure per square inch, being 1672 times that of water, it is plain that if S represent the number of cubic feet of water vaporized per minute in the boiler, and if a represent the area of the cylinder expressed in square feet, 1672 S will be the volume of the steam generated per minute whence results that $\frac{1672\,S}{a}$ will be the velocity, in feet per minute, assumed by the piston of the engine working at that pressure. Moreover, the *effective* pressure of the steam or the load which the piston can support, is $16 - 4 = 12$ lb. per square inch; which gives $12 \times 144\,a$ for the total resistance, in pounds, supported by the piston. Thus, in the condensing engine, the effect produced by the number S of cubic feet of water, expressed in pounds raised one foot per minute, is $1672 \times 12 \times 144\,S = 2{,}889{,}216\,S$. Calculating in the same manner the case of the locomotive engine, we find that the effect it produces for the same vaporization S, working at the total pressure of 75 lb. per square inch, or at the effective pressure of 60 lb. per square inch, and expressed in pounds raised 1 foot per minute, is $381 \times 60 \times 144\,S = 3{,}291{,}840\,S$. Therefore, finally, its useful effect, per cubic foot of water vaporized, will exceed that of the condensing engine, and this again is a circumstance, examples of which will be found in the *Theory of the Steam Engine*.

Thus this new peremptory condition which the experiments ought to satisfy is as unfounded as the former ones; and, in fact, Mr. Parkes contradicts it, himself, a little further on (pages 157, 158), so that we might have referred his first argument to his second, for refutation. But, besides the foregoing observations it must be borne in mind that the velocities employed by Mr. Parkes, for locomotive engines, being nearly all considerably augmented, as has been explained above, he must necessarily arrive (pages 85, 87, 89, 92, and tables x., xiii., xiv., xvi.), at exaggerated results, for the effects which he supposes to have been produced by those engines; and therefore his comparison between locomotive and stationary engines, is altogether founded upon false calculations.

It is remarkable, finally, that in applying the preceding considerations to all the experiments published on locomotive engines, by different engineers, namely, Messrs. R. Stephenson, N. Wood, E. Woods, and Dr. Lardner (pages 102, 117, 118, 159), Mr. Parkes finds that the conditions to which he proposes to subject those experiments are not verified in them. Such a result ought to have put him on his guard against the validity of his own arguments; but the want of knowledge in the principles of Mechanics and of habit in mathematical reasoning (the author tells us that he is more accustomed to handle the hammer than the pen), causes him to heap errors on errors, combining and complicating them unawares, till he arrives at a point where he does not produce a single result that is not erroneous.

There is a matter of surprise in the numberless errors contained in the paper of Mr. Parkes, and of which, for the sake of brevity, we have noticed merely the principal ones, reserving the rest for another opportunity if necessary. But on inquiring what was the end he had proposed to himself, what was to be definitive consequence of his labour, one is yet much more surprised.

His object is to propose a new measure of the effect of locomotive engines; and this *new* measure is what he calls the "momentum" generated, that is to say, "the product of the mass, in tons, of the engines, tender and train, multiplied into its velocity, in feet per second." This standard is to "represent the repective mechanical effect produced per second by each engine" (page 128).

Now, the true mechanical produce includes the whole of the resistances and frictions really overcome by the engines; that is to say, the friction of the carriages, the friction of the engines, the gravity of the mass on the different inclines traversed, the atmospheric pressure, the pressure due to the blast-pipe, the resistance of the air, &c.; and in multiplying the sum of all these resistances, by the velocity of the motion, we shall have the mechanical effect produced. But, if among all those divers resistances, we take account *only* of the friction of the carriage, and the engine, omitting all the rest, and if we suppose, for an instant, that friction to be 6 lb. per ton, as well for the engine as for any other carriage, we shall have the effect produced, in multiplying the weight of the train, tender and engine included, first by 6 lb., and afterwards by the velocity of the motion. Now, it is evident that in calculating thus, we shall have exactly the same number given by the computation of Mr. Parkes, excepting that all of them shall be multiplied by 6. Therefore, the new measure proposed comes merely to this, that the effect of the engines will be calculated by the friction of the carriages only, and that of the engine considered as a mere wagon, and the results divided by 6.

But, as this pretended "standard" comprehends only a portion of the resistances really overcome; as it does not include the gravity of the train, which may, according to circumstances, offer a resistance exceedingly great, or null, or even act in favour of the motion; as it does not include the counter-pressure due to the blast-pipe, which varies according to the velocity, the rate of vaporization and the size of blast-pipe; as it does not include the total friction of the engine, but only the friction of its wheels, as a single wagon; as, above all, it does not include the resistance of the air, which, from experiments of which Mr. Parkes is "utterly ignorant" (page 124), varies according to the bulk of the train and the square of the velocity, so that the quantity neglected, on that account, in the calculation may, at times, be quite trifling, and at other times, exceed the *momentum* of Mr. Parkes itself; as in fact this pretended *new* measure is nothing more or less than the common *useful effect* of the engine, as given in many works and particularly in our *Theory of the Steam Engine*, and *Treatise on Locomotive Engines*, with these differences only that in Mr. Parkes's calculation, it includes also the weight of the engine, and that it is erroneously computed, inasmuch as, in multiplying the weight of the train, in tons, by the velocity, the calculation is made as if the whole weight were raised up in the air by the engines, instead of being dragged or rolled along the rails; as, finally, this pretended standard, instead of being constant, varies with the velocity, just as well as what Mr. Parkes calls the *commercial* and *useful* effects, so that it is not more easy to know the one than the others, or that the rule of Mr. Parkes, which we are going to quote, refers to the one just as well as to the others; for all those reasons, then, we see that the aforesaid measure is not new, that it does not measure the mechanical effects of the engines, and finally that it is nothing more or less than the common useful effect (weight of engine included), calculated in considering the whole train raised up in the air and the engine as a mere wagon.

After having thus found upon *reasoning* the accuracy of his new measure of the mechanical effect of the engines, Mr. Parkes proceeds to show the "powers of this method of analysis" (page 131). Collecting all the erroneous results which he has obtained in his tables, and admitting then, as accurate, the experiments of the *Treatise on Locomotive Engines*, which he thought of demonstrating false before, Mr. Parkes forms a table in which he sets in view, on one side, the vaporization effected by the engine, and on the other side the useful effect produced, giving it only the name of *momentum* when it includes the weight of the engine besides that of the wagons. Then comparing the vaporization to the effect produced, and taking an average, not upon his own experiments, *since he has made none*, but upon all the experiments which he has collected from the divers works published on the subject, he presents (page 130), as the result of his labours, the following conclusion, which he proposes to substitute in place of every other kind of research on locomotive engines.

When the velocity of a locomotive engine is augmented in the proportion of 1·52 to 1, the vaporization necessary to produce the same effects varies in the following proportions:

To produce an equal *momentum* (an equal useful effect, weight of wagons and engine included), in the proportion of 1·42 to 1, or in a proportion something less than that of the velocities; to produce an equal *commercial* gross effect (an equal useful effect, including the weight of the wagons), in the proportion of 2·43 to 1, or nearly as the square of the velocities; to produce the same *useful* effect (the same useful effect, net weight), in the proportion of 8·11 to 1, or nearly as the cubes of the velocities.

This is the definitive result which Mr. Parkes has attained, and the help of which seems to him to render it needless henceforward to seek to determine either the friction of the wagons, or that of the engines, or the resistance of the air, or any thing in fact that may influence the effects produced; researches which appear to him to offer insurmountable difficulties. Possessed of the *wholesale* result of Mr. Parkes, nothing more will be needed. Does any one wish, for instance, to know what load a given engine will draw at 25 miles per hour, on a given inclination? to know what velocity it will assume with a load of 60 tons? to know what is the maximum of useful effect that it is capable of producing? to know what proportions must be given to it, in order to obtain desired effects? Why, having recourse to Mr. Parkes's result, the solution of all these questions is self-evident!

It is evident, on the contrary, that Mr. Parkes's result, even were it exact instead of being founded on erroneous calculation, could lead to but one thing, namely, to find the useful effect produced by an engine at the velocity of 30 miles per hour, when the same effect, in quite similar circumstances, is known at the velocity of 20 miles. But, even then, making use of so rough an approximation, in which all is thrown in the lump: friction of the wagons, friction of the engine, resistance of the air, resistance owing to the blast-pipe, &c., the result could never be depended on. Assuredly, calculations like these do not tend to the progress of science; they would rather lead it back to its first rudiments. For this reason we persist in our belief that the only means of calculating locomotive engines, is to endeavour to determine, as exactly as possible, each of the resistances which oppose their motion, and by taking an account of the value of those forces in the calculation, we may then in every case attain a valuation really founded in principle, of the effects of every kind that are to be expected from them.

MR. RANKIN'S WOOD PAVEMENT.

(Abridged from the Polytechnic Journal.)

This new wood pavement is the invention of Mr. Rankin, and manufactured by Messrs. Esdailes and Margrave at their City saw-mills. We will first proceed to describe the process of its manufacture from the beginning. A square-sided piece of timber, of a proper length, is provided, each side being four inches across. By the application of the steam machinery at the saw-mills, two equilateral *grooves* are rapidly cut along the whole length of the piece. As soon as this operation is performed, the piece is turned completely over, and on the side immediately opposite to that previously grooved, two *tongues* are cut, in like manner, along its whole length.

The length of timber, thus prepared, will have two sides opposite o each other with plain surfaces, one of the remaining sides *grooved*, and the other *tongued*; and in this state it is ready to to be cut into blocks, to be laid down as street pavement.

Simple as this grooving and tonguing may appear to be, they constitute, in fact, a principal part of the merit of the invention. The fundamental principles of geometry have been strictly attended to in their construction, and the result is consonant with an adherence to scientific laws. The tongues of one piece of timber fit into the grooves of another; and when two pieces are thus united, the are not *flush* with each other, but the side of the second piece projects beyond the side of the first to which it is fastened, exactly half its own width. If a third length were attached to the second, in the same way that the second was to the first, the edge of this third length would again project beyond that of the second, half its width, and the same effect would be produced with any number of pieces.

The lengths, first prepared in the way described, will then have to be cut into blocks. In order to facilitate information on this part of the plan, we here introduce a diagram.

Fig. 1.

It will be observed there are two shaded parts, C and D, one at each end of the length. These are cut to waste; but the amount of loss is so small as hardly to be worth consideration in any estimate of prime cost. With this trifling exception, the whole of each piece, no matter how long it may be, is brought into use. The dotted lines, which intersect the length, indicate the direction of the saw when it is converted into blocks. A A A are base-blocks, and B B B the key-blocks. Let us, for the sake of an example, suppose that one length is cut into six blocks. Of these, three are intended to be laid upon the ground with their bases downward, and the other three to form the surface of the pavement by reversing this position, and placing their bases upward; and this is the only distinction between the blocks of which Mr. Rankin's pavement is composed. The lower blocks are called base-blocks, and these support the others; the upper blocks are called key-blocks, and these firmly interlock the under blocks and themselves together. The annexed drawing, fig. 2, represents the *grooved* side of a base-block, *a* and *b* being the grooves; and the engraving opposite fig. 3, presents the *tongued* side of the same base-block, *a* and B A being the tongues. The two similar sides of the key-block are also exhibited in the accompanying diagrams; *a* and *b* in fig. 4, representing the grooves, and *a* in fig. 5 the *tongue*. Such is the shape of the blocks of this most ingenious pavement; and begging our readers to bear in mind that there are but two sets, upper and lower, and that the individual parts of every block of each set are geometrically alike, we proceed to the proof of its advantages, with the promise of which we started.

Fig. 2.

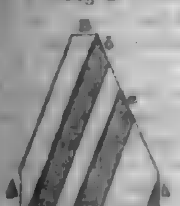


Fig. 3.

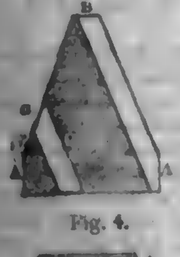


Fig. 4.

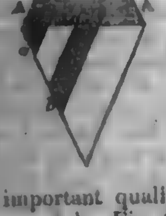
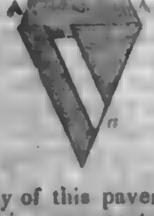
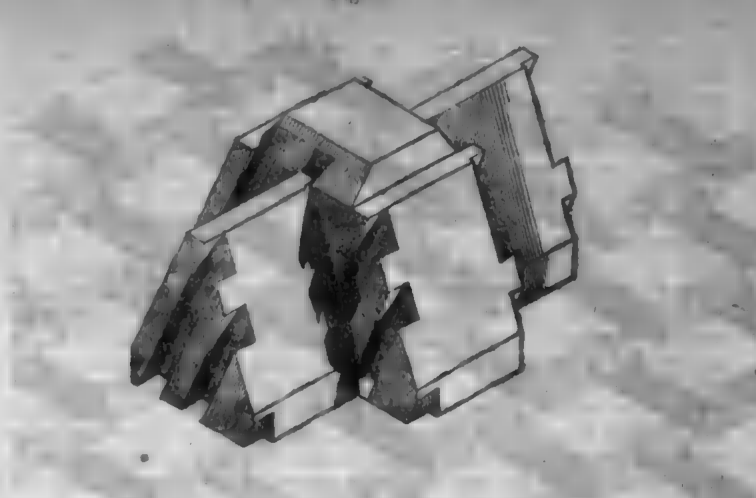


Fig. 5.



As "UNCHANGEABLENESS OF POSITION" is a primary and most important quality of this pavement, we will first explain how this is secured. Fig. 6 is a representation of five blocks locked together. It will be noted that four of these are base-blocks, and but one a surface block. If examined in detail, it will also be found that the key or surface block is supported by the others, and by all equally; and that no surface pressure can separate them laterally, or drive them asunder; so that any weight applied at the surface, is distributed over a base nearly four times its area; but these four base-blocks likewise respectively lock in with four other different series of the same kind, and so on continuously from side to side of the street, where they rest on the kerbs, and longitudinally from end to end of the pavement; and thus

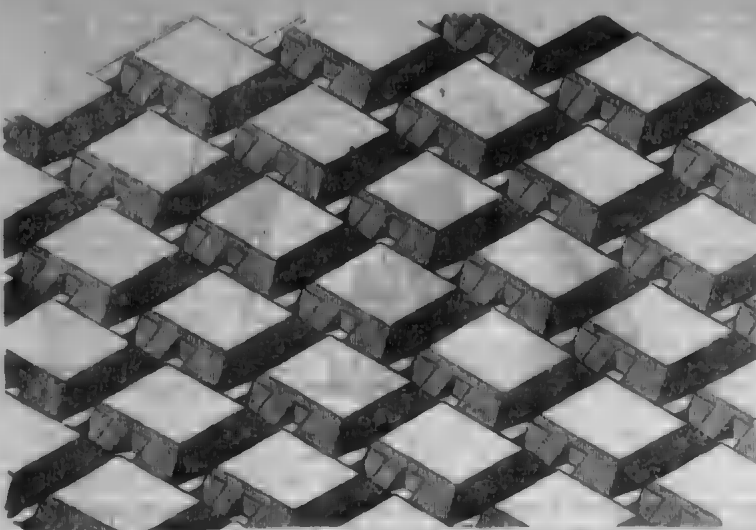
Fig. 6.



the weight applied to an individual surface block is not confined to the four base-blocks, its immediate supporters, but is transmitted throughout the whole structure, and no one part can yield to the superincumbent pressure, without causing a general deflection from kerb to kerb; and as this is manifestly impossible, except to a small amount, it must be granted, that the base of the pavement can never be affected, or dislocated, by any traffic whatsoever; no inequality of surface, from the sinking or depression of individual blocks, can consequently arise, until the surface blocks themselves are fairly worn out, a result which is assuredly much more remote in wood than the public are yet prepared to believe. The construction of this pavement, therefore, as regards uniform stability of base, places it beyond all comparison with any stone paving now in use, because it includes the principle of the arch, the kerbs representing the abutting piers, and the upper or surface blocks the key-stones; and the greater the weight, the more solid does the structure become by the tightening process of the wedge-shaped key-blocks, with their grooves and tongues. If our readers will again examine figures 1 and 2, they will observe that the angular terminations on two opposite sides of the base of every substratum block (A—A) are chamfered or squared; and if, farthermore, they will suppose a row of these blocks to be placed on the ground between two piers, or abutments, with their chamfered edges together, and the upper blocks afterwards introduced in their proper place, it will at once be evident that no sinking can take place without complete destruction of the parts. In truth, by this arrangement of shape, unchangeableness of position is absolutely obtained.

But, after all, the most important consideration in the adoption of wood as a substitute for stone in the street-paving of the Metropolis, will ever be the providing an effectual REMEDY AGAINST SLIPPERINESS. No pavement of wood, that does not offer a firm foothold for the horse in all states of weather, will ever become generally adopted in London. In every situation, whether in continuous motion, in backing, in being abruptly pulled up or suddenly started, the horse must be able to maintain his feet in precisely the same place in which he places them down, otherwise wood pavement will not have realised the grand advantage of which it is susceptible. That nothing of the kind has been hitherto accomplished, needs but a five minutes' examination of any public street paved with wood immediately after and during the existence of a passing shower. The plunging and sliding about of the animals are then awful. If an omnibus going at the usual speed were suddenly required to be stopped to take up a passenger, its momentum would force the horses along the pavement several yards, in spite of all their efforts to prevent it. In starting too, their feet rapidly slip from under them for several moments before they can succeed in moving the vehicle. Frequently they fall down and are injured, and the greatest precautions are necessary under such circumstances to prevent accidents. These things happen because there is no foothold for the horse in damp weather upon any of the wood pavements hitherto introduced. We can testify, of our own knowledge, that the reverse of this is the fact in the case of Mr. Rankin's pavement. Indeed, it speaks for itself; no argument is required to prove that the foot of a horse cannot slip over its surface. At the same time it offers no resistance to the uninterrupted progress of the wheel, and therefore a remedy against slipperiness is not obtained by any sacrifice of facility of traction. A general character of the paving may be gleaned from the annexed engraving.

Fig. 7.



Here, then, as the licencees fairly remark, is a pavement, removing at once the great and hitherto insurmountable evil attending the use of wood, the insecurity of the horse's foothold; and offering a facility of removal equal to the present stone paving, and an evenness of surface, and combination of construction, together with an absence of noise and increase of cleanliness, which wood alone can give.

We have felt great pleasure in thus calling the attention of the public to the invention of Mr. Rankin, because we know it to be very ingenious, and believe it to be, for all seasons, by far the best wood pavement hitherto made public. The government ought to allow an experiment upon an extended scale to be made with it duty free, for the question of wood pavement is one of metropolitan, if not of national, convenience.

PROFESSOR FREUND, DANISH SCULPTOR.

If not in the fine arts generally, the north of Europe has distinguished itself in sculpture—that one of them, on which the fame of Greece now chiefly rests, and which more especially demands a critical study of beautiful forms and proportions. The eminent and excellent sculptors Sweden and Denmark—and we may add Russia—have given birth to, sufficiently vindicate their pretensions and character in that branch of art. The names of Martos (+1835) and Boris Orlovsky (+1837), of Sergell, Bystrom, and Fogelberg (belonging to Russia and Sweden), may be said to be European ones, while that of the great Danish master almost dims that of Canova himself. Neither is it of her Thorwaldsen alone that Denmark has cause to be proud, since she can boast of having given to the world another highly gifted sculptor in Hermann Freund, who died at Copenhagen in July 1840.

Of this last-mentioned artist we are not as yet prepared to give any biographical sketch, nor even to enumerate his principal works. We are enabled, however, to state a few particulars relative to some of his subjects from ancient northern mythology, which had been a favourite study with him, and of whose imagery and traditions he sought to avail himself for plastic and sculpture, in like manner as his countryman Oehlenschläger has done for poetry and the drama. It was here that he displayed poetical conception, a noble simplicity, a characteristic yet graceful severity, free from aught like mannerism, and from those mere conventionalities upon which so much stress seems to have been laid by most modern sculptors, to the exclusion of either originality or feeling. Among the works of the class above referred to, is a bas-relief representing the three Nornas or northern Fates, who are consulted by Mimer, Baldur, and the Valkyrias, in consequence of Iduna, the goddess of youth, having been carried off by the evil spirit Loke, and thereby both gods and mortals subjected to the infirmities of age and decay. In this dilemma Baldur, the Apollo of the Scandinavians, solicits the counsel of Mimer, the god of wisdom, and he, being unable to assist by his advice, they both proceed to solicit that of the Nornas. These last form the centre group in the composition, and represent Veranda, she who presides over the *present*, Ur, who presides over the *past*, and is here seen recording its events upon a tablet; and Skulda, or the *future*, with her finger upon her lips. To the right of these figures are those of Mimer and Baldur, the former with a long beard and arrayed in a bear's skin, the other a beautiful youth, vying in form with his classical prototype. To the left of the centre group are the three Valkyrias (whose office it was to tend upon the souls of the blest in Valhalla, the Scandinavian Elysium), who are here represented as attired in long under garments, and with wings growing from their temples.

Among Freund's single figures and statues are many representing personages belonging to the same mythological system: viz. Odin, Thor, Freya, Iduna, Bragur & Loke. The first-mentioned of these is seated on a throne, and wears a diadem inscribed with Runic characters. He is the Scadinavian Zeus, and like the Grecian one, is distinguished by majesty of appearance, but his features are more aged, his form less expressive of strength; for though superior in power to the rest of the deities, Odin was supposed to be himself under the control of Fate—an arbiter more awful and tremendous than even the sovereign of the gods. His attributes are two ravens, seated on the arms of the throne, which were the messengers commissioned to bear his orders to gods and mortals—and two wolves couched at his feet.

Thor or the Thunder-god, is a standing figure, with his right foot advanced forwards, and looking earnestly on one side. He is here supposed to have just hurled forth his lightning, and to be striking a thunder-peal with his hammer. This figure—which is somewhat between that of a Jupiter and a Hercules—is quite naked with the exception of a wolf's skin, hanging upon one arm, and reaching to the ground. Beside him is a coat of mail, which serves to support and balance the statue. In a second figure he is somewhat differently represented—in a more composed attitude, with his hammer in his right, resting upon his armour, and a thunderbolt in his left.

In the group of Freya, the goddess fabled to preside over sexual passion, that figure is represented veiled, resting her chin on her right hand, and holding a wreath of flowers. On one side of her is Siofne (under whom was typified the first emotion of love), endeavouring to draw aside her veil and behold her countenance; while on the other is Hnos, or Enjoyment, with her left arm around her mother Freya's neck. Both Siofne and Hnos are naked figures. So far the allegory seems well conceived, but there is one circumstance which, though it may be significant enough as a symbol, is far more associated with the ludicrous, than with either the sentimental or poetical, according to modern ideas; for instead of turtle-doves, the northern Venus has at her feet—two cats! as images of the potent influence of *la belle passion!*

Iduna, the Scandinavian Hebe, is represented by a graceful youthful figure, holding in her left hand a patera filled with apples, and in her right a cup of mead. Her luxuriant tresses fall from beneath a long pointed cap, similar to that still worn by the maidens of Iceland, which hangs down behind, where it terminates in a tassel.

Bragur, her consort, and the Scandinavian deity of poetry and minstrelsy, and whose office it is to recreate the inuwellers of Valhalla with his songs, is shown in the act of playing upon his harp, which is attached to a riband that crosses his shoulders.

The evil malicious spirit, Loke, is characteristically described—under a shape speakingly expressive of the disposition attributed to him. There is something stealthy in his very attitude, as he creeps along resting his chin upon his left hand, while brooding upon mischief. His other claw-shaped hand is partly concealed beneath his mantle, as are likewise his long and ugly ears, and his bat-wings.

However admirable may be the talent manifested in those productions, it is with us a question whether it might not have been more advantageously employed. If heathen mythology is now worn out, if it does not address itself to our sympathies, especially when served up—as it necessarily must be in modern sculpture, at second-hand; that of Scandinavia has to contend with the additional disadvantage of being less known, consequently less intelligible. All attempts to revive it, to bring it again into vogue, either in poetry or the graphic and plastic arts have proved comparative failures. Did the fame of Gray rest chiefly upon his productions of that class, it would be much less than what it actually is; or rather, he would share the fate of Sayers, whose northern poetry has been descanted upon and praised by critics, to be forgotten—supposing it ever to have been regarded—by the public.

A new Paving.—M. Polonceau, the engineer of Paris, proposes a new mode of paving for Paris, consisting of artificial stones made of clay, sand, and pulverized charcoal. This mixture stood heat well, and became vitrified; it also dried without cracking. The stones were made in an hexagonal form, and could be put down or taken up one by one. Government had given leave for an experiment to be made of this system in one of the streets of the capital.

COMPETITION DESIGNS.

(Benevolent Institution for the Relief of Aged and Infirm Journeyman Tailors.)

The mal-administration of competitions for designs becoming every day more apparent, the indignities and imposition practised upon architects who are foolish enough to yield to importunity and submit the result of their labours to the decision of men not merely unfitted for the task, but in most cases *prepared* to decide in a certain manner even before the reception of the drawings, becoming additionally glaring, it surely only needs that some few more home-cases should be brought forcibly before the public eye to induce the entire abandonment of the present scandalous system, and to enforce from committees an honest decision and something like consideration for the time and talents of the professional men applied to. With this view we proceed to lay before our readers the particulars of a recent competition which have come to our knowledge in the hope that the statement may aid in rousing public indignation against such proceedings: furthermore, we have a latent hope that by putting the whole matter fairly before the parties interested they may be led, as it is not yet too late, to retrace their steps.

Some few months ago the Committee of the Institution named at the head of this article, requiring designs for an asylum which they propose to erect in the Hampstead Road, invited a limited number of architects to forward drawings, namely Messrs. Lee and Duesbury, Mr. Jones, Mr. Vulliamy, Mr. Thomas Meyer, Messrs. Winterbottom and Sands, Mr. George Godwin, and Mr. E. H. Browne.

It being understood that one of the competitors, namely Mr. Meyer, was brother of a member of the Committee and had already sent in a design, some of the other architects inquired pointedly whether or not this gentleman was to be in any degree considered more than the rest, and were informed by various members of the committee that the best design would positively be accepted whether made by Mr. A. or Mr. B. Designs were accordingly sent in by all the gentlemen we have named. A building committee was appointed by the general committee to examine the drawings, and recommend for adoption that which they considered the best. They accordingly met various times, gave a long consideration to the matter, and ultimately selected Mr. Godwin's design as the fittest for their purpose; a written report to this effect was drawn up and the matter was talked of out of doors as a thing settled. Several weeks having elapsed after this had reached Mr. Godwin's ears accidentally, without his receiving any special communication, he applied to know how the competition had terminated, and the following letter was shortly afterwards sent to him:

Benevolent Institution, &c.
32, Sackville Street,
14th July, 1841.

SIR—I beg leave to inform you that, by a decision of the Board of Directors, their choice of an architect has fallen on Mr. Meyer.

I am, Sir,
Your obedient servant,
George Godwin, Jun., Esq. T. P. DAVIDSON, Sec.

The gentleman to whom this was addressed accordingly called the next day to fetch away his drawings, and being shown into the room of meeting, saw there five of the seven sets of designs, including those selected as the best. In consequence of this examination he immediately addressed a letter to the Board, which, as it puts the whole matter in the fairest point of view possible we here annex

To the President and Directors of the Institution for the relief of infirm Journeyman Tailors.

Brompton, July 17, 1841.

GENTLEMEN—I have the honour to acknowledge a note from your Secretary, stating "that the choice of an architect has fallen on Mr. Meyer."

Some time previously I was told, in three different quarters, that *my* plans had been selected by the Committee as the most approved, and I felt, therefore, a little disappointed on receiving official intimation to the contrary; still, considering that I must have been misinformed, I was of course quite disposed to bow to the decision in silence, and to believe that a better plan than my own had been chosen.

Applying, however, a few days back in Sackville Street to regain the drawings, I there saw the various designs of the other competitors. Amongst them were those of the preferred candidate, and an examination of these led me to the conviction, that such a decision had not been come to as those architects who had given their time and attention to the subject at the request of the Board, had every right to expect. I make this remark with the greatest deference to every member of the Board, for many of whom personally I have great respect.

Far be it from me to deny that the Board had right to appoint any architect they pleased; what I would very deferentially submit is, that having induced six or seven architects to make plans for the proposed asylum, at an expense of both time and money, in the full persuasion that the author of the best design would be appointed to execute the building, the Board were bound to make that selection solely on the ground of *superiority*, and without reference to the name of the author of the plan.

That such has not been the case, referring solely to the designs submitted, and without the slightest intention of disparaging Mr. Meyer's fitness for the task, I venture without hesitation to assert.

Apart from private grounds (and even in this respect, as my plan was selected by the Building Committee after due consideration, as the best adapted to your purpose, I am, perhaps, authorized to address you,) I am induced to this step by strong public motives—by that desire to obtain a just administration of competitions for designs which is felt at this time by all those who wish the prosperity of the arts in England.

On this ground then, gentlemen, I appeal to your sense of justice, and the desire which, I will venture to believe, you all have to maintain the good opinion of the world, to give this matter re-consideration.

I hope sincerely that you will not deem any thing I have said disrespectful in the slightest degree, and that you will permit me to subscribe myself, gentlemen,

(Waiting your decision),
Your humble servant,
GEO. GODWIN, Jun., Architect.

The result of this letter was that the Board, at their next meeting, refused to confirm the appointment of Mr. Meyer, and it was proposed that the whole of the designs should be referred back to the decision of one or more architects. A subsequent meeting, however, influenced in a manner one would hardly venture to hint at, overturned this intention and confirmed the original appointment. Here the matter stands. We have seen the various plans, and without stopping to inquire whether Mr. Godwin's plan is the best (a point we don't in the least care for), we have no hesitation in saying that not merely is the selected design *not* the best, but that it is perhaps the least entitled of any one of the seven to claim for its author the appointment. If the Board desired to employ Mr. Meyer, why did they not do so in the first instance? No one would have questioned his fitness, or their right to appoint. But having given seven gentlemen the trouble, and led them into the expence, by special invitation, of preparing designs, we assert that the Board were bound, by every feeling of honesty, to appoint the author of the best plan, without the slightest reference to his name or his connexion with the society. We hope even now it is not too late for redress.

COMPETITION.

SIR—If your readers will refer to the Athenæum for the last month, they will find an account of a highly entertaining squabble arising out of the competition for a new church in the parish of Paddington.

When this competition was announced, I applied for the particulars, and subsequently for further information on a few points which did not appear to my humble comprehension to be quite explained in the instructions. Without troubling you with the whole list, I will mention one question, viz. How many of the prescribed sittings were to be in pews, and how many in free seats? to which I took the liberty to add the further inquiries, whether any member of the vestry would be permitted to compete, and to whose judgment the designs were to be submitted. To which answer was made, to the first question, that many architects had applied for the like information, but that the instructions already given were considered sufficient—to the second, that no member of the vestry *could* have an interest in any parish work—and to the third, that it was calculated to give great offence! and that it was quite enough for the architect to know that the parties concerned were "all honourable men."

Of course all applicants were obliged to be content with the same answers, for, *of course*, nobody gave, or profited by, private information—nobody ever does. I submit, therefore, that any one who competed after receiving such answers, got what he deserved, whatever he may have or may think he has to complain of, and I trust that none of the profession who lend themselves to the system of scrambling for jobs in the dark, will ever be better treated.

I am, Sir,
26th August. Your obedient servant,
T. J.

ON RAILWAY CARRIAGE WHEELS.

SIR—In your number for June last, there is a paper, page 197, professing to contain accounts of improvements in Railway Carriage Wheels.

The writer's first two heads of method contain two different modes of constructing the axle of a pair of wheels, to allow these to turn independently. One would infer from his manner of stating the modes, that they should be united in one pair. They evidently cannot. At all events, he implies that, on either plan, the independent rolling of

the wheels, together, I suppose, with the additional flanges, would entirely prevent the engines being thrown off the line by an obstacle. Now the *independence* of their rates of motion cannot facilitate the prevention of such an accident.

In his third head he tells us that his wheels should be of cast iron, preferably to malleable iron. But why this preference? It is universally agreed that malleable iron is superior to cast iron for all wheels of the kind now in use. Why are the writer's wheels to be an exception? Is it on account of spreading? The writer himself says that malleable iron wheels spread out only on the bare side. And, therefore, now that they are to be flanged on both sides, the spread will be checked, therefore let us yet use malleable iron. There is no other new circumstance requiring this change of metal. The jolts, strains, and every thing else will be the same. Again, therefore, let us yet use malleable iron. His preference for cast iron is of a kind with the dislike of Dr. Pell versified in the immortal quartet so often quoted. Again, he says that the wheels as they are double flanged will not require to be so strong as at present, because side jolts will be divided between the opposite wheels. The consummation of lateral strains and jolts would be both wheels rising on the rails, which case, therefore, we must consider in judging of the required strength. Admitting the writer's assumption that both wheels share the strain equally, (which however cannot always be, as in cases of variation of gauge, which fact itself is an argument against his conclusion), it is clear, as Telford has it, that the engine on being raised, is elevated on both rails through the depth of flanges, and that therefore its centre of gravity also rises through the mean depth of flanges. Now with the single-flange wheels the engine would be raised only on one side, through the depth of flange, and therefore its centre of gravity rises through only one half this depth. It is clear again, then, that double flanged wheels would have as tight work each as the single flange wheel, and therefore *would* require to be as strong. What right has he to deny this, who never proved the contrary? He again says that the face of the wheels ought to be in outline a circular segment instead of conical. Now the face of a wheel, as he views it, is not conical; it is a straight line inclined to the axis. He proceeds to mention by wholesale the great saving in his plan. Particularly, he says, no attention will be required in laying the rails to an angle in straight parts. What although, there will be the same attention altogether in laying them horizontally? At all events, he allows that the angular position is required at curves. But under the fifth head, he says that railways are all curves together; therefore he must conclude against himself that the saving in straight parts is just nothing, since he supposes there to be no straight parts at all.

Again, he says that the inclination of the rails the same way on curves instead of towards each other, as now set, will enable gravity to act more forcibly. This can be only on the ground that the comparative virtual velocity in the direction of gravity is greater in the first case than in the other. The writer has evidently not troubled himself as to the truth of this gratuitous statement. It would be easy to prove that the centre of gravity moves through equal depths for the same horizontal movement, in both cases. And therefore is he entirely wrong.

Again, he says that the inclination of the rails to one another in present plans causes great friction on the journals. How so? The pressure on the journals must be the same. Nor is there any twisting or other adverse action of the kind. In fact, the only sources of friction by this cause would be at the contact of wheels and rails, owing to the wedge-like action of the conical wheels, which is utterly insignificant. Again, each wheel cannot possibly press the other against the rail, for their action is equal and opposite, and therefore nothing.

In his fourth head he has asserted all, proved nothing. How did he know the exact saving of power he mentions? It is evident that his improvement was never in operation. What right had he then, when he knows nothing about it, to pronounce so decisively as he has done, and that not only in this paragraph, but throughout the whole paper.

His last notable and most ridiculous statement is set down in the fifth head. He tells us that railway curves do all differ in intensity, and they must therefore be of various radii. But this evidently requires wheels of various diameters to suit them, and to produce that sweetly-gliding motion which he loves. This exigence is beautifully provided for in conical wheels. Now he proposes to set his engine running upon the flanges of the wheels forsooth when they enter upon curves. By this exceedingly quack plan, the wheels are evidently adapted to only one kind of curve, and would therefore, on any other curve, grub up the rails most sweetly indeed.

I am, your's, respectfully,

D. C.

Glasgow, July 9, 1841.

QUESTIONS FOR THE OPINION OF THE EDITOR.

SIR—I shall feel obliged if you will inform me if I could sustain a charge in a court of law under the following circumstances. In the early part of the year I was applied to, amongst other tradesmen in the parish, to tender for certain alterations and additions required to a building, in the erection of schools, and in due course I was informed that my tender was accepted, and that a delay of a week would most likely take place, but from that time to this, a period of six months and upwards, I heard nothing of the matter until a day or two since, when I received a letter (certainly a polite letter), stating circumstances prevented the design from being carried into effect, and that they were sorry I could not have an opportunity of carrying my contract into effect.

Do you not think, Sir, I should be fully justified in charging two per cent on the amount of my tender, as some judgment was necessary and much time taken up in making the estimate.

I am, Sir,
Your obedient servant,
Aug. 9. T. O. M.

In all cases when our opinion is required, we should be furnished with full particulars; for instance, in the above case, a copy of the advertisement should have been forwarded. Taking for granted that there is nothing very special in the wording of the advertisement, and that there was nothing personally objectionable to the tradesman making the tender as to his general way of doing business in point of construction, or for want of pecuniary means to fulfil his contract, we are then of opinion that a claim could be legally substantiated against the parties advertising.

We have some recollection of a case being tried about six months since, either in the Sheriffs' or Secondaries' Court in London, of a builder suing a person for the trifling sum of about 3*l*. for his loss of time in making an estimate of some works; after receiving the tender, the defendant declined employing the plaintiff, without showing any reasonable excuse; in this case the plaintiff recovered the sum sued for. Our impression is that there are other cases which might be cited; probably, before our next number appears, some of our readers will be able to furnish us with some information regarding this question, which is one of very great importance, not only to the builder, but also to the profession.—EDITOR.

SIR—I thank you for your reply respecting the legal arrangement of chimney flues, and from which I gather that the termination at top, if of different materials from the stack, may be of any size that one pleases; but suppose I choose to have nothing resembling a chimney-pot, is it your opinion that the law will forbid such a contraction for the last two or three feet of the brick or stone, as is now effected by the addition of the cement or pottery abominations?

I am, Sir,
Aug. 10. Your obedient servant,
A subscriber.

If the chimney be built as our correspondent suggests, it will be necessary, in our opinion, to construct it with an aperture not less than 14 in. by 9 or 12 inches diameter, agreeably to the Act. We hope that the legislature will see the necessity for altering the clause in the act before it comes into operation; the Architects' Institute or Society should interfere and obtain a repeal or modification of the objectionable clause before the act comes into operation.—EDITOR.

SIR—I have lately had an opportunity of seeing the Illustrations of Ancient Halls by Nash. Now it struck me at the time, that though they were certainly very pleasing to the eye, how much more *useful*, simple but correct outline elevations and plans would have been to the architect and others, as it would be the means not only of preserving a true delineation of the subject, but would also be the means of furnishing numerous data in erecting similar edifices, which I know to be useful to all. Now as many very beautiful specimens still exist in this part of the country, I have it in contemplation to bring out a work of this kind. The only question is, whether architects will patronize it as they ought to do, as I am sure plans, elevations, &c., of such buildings must be very acceptable to them. If you will be kind enough to give your opinion in your next number, I shall feel greatly obliged.

A SUBSCRIBER.

Such a work as our correspondent describes has already been commenced, but not proceeded with. We think a work got up at a moderate price, suitable for the architect, might stand a chance of meeting with support, but we are afraid to recommend the publishing

of it, as it is very doubtful if our correspondent would be remunerated for his labour.—EDITOR.

MOVEABLE FURNACE BARS.

SIR—With your permission I beg to make the following remark respecting an article which appeared in your valuable Journal of last July, under the head of "New Inventions and Improvements." The article in question is one which I suppose to be an extract from the specification of Mr. C. W. Williams's patent improvements in furnaces and boilers.

If there be any credit due to the discovery of the method therein described, for producing the continual up-and-down movements in the grate bars, that credit is most certainly due to the late Mr. Mathew Murray of Leeds, who had the furnace of an eight horse steam engine, so constructed as to keep the grate bars continually in motion, by means of small eccentrics formed on a horizontal shaft, which revolved beneath, and supported the ends of the grate bars next to the furnace bars. This was done with an intention to prevent the formation of clinkers, and to keep the fire perfectly clear; but, as the plan did not prove perfectly satisfactory to the inventors, the whole system was very shortly taken out, and replaced by that then most commonly adopted. It appears to me somewhat singular that this contrivance, though upwards of fourteen years old, should at length become the leading feature in a specification of patented improvements.

I am, Sir, with great respect,
Your humble servant,
FLORENTINE.

Holbeck, August 16, 1841.

REVIEWS.

A Series of Original Designs for Churches and Chapels in the Anglo-Norman, Early English, Decorative English, and Perpendicular Styles of Ecclesiastical Architecture, including also designs for Rectory Houses and Schools in the Domestic English and Tudor Styles. By FREDERICK J. FRANCIS, Architect. London: John Weale, 1841.

This forms the first part of a series of original designs, which are divided into four classes. 1. The Norman. 2. The Early English. 3. The Decorated English, and 4, the Perpendicular English. We do not think however from the specimens before us that Mr. Francis is so happy with his pencil as with his pen, neither are we of opinion that these designs are likely to induce the Church Building Commissioners to abandon their "Barn Church Architecture." We might instance several defects, for instance in design No. 1, we have the principal entrance opening direct into the body of the Church without any lobby, or second entrance; the same again in the side entrance of No. 2, nor do we admire the stunted steeples which have been introduced in designs Nos. 2 and 6, the pedimental parapet of No. 7. and the stepped parapet of No. 12 design, nor the square hood moulding over the pointed windows of the clere-story.

Description of a Series of Geological Models. By T. SOPWITH, M. Inst. C.E., F.R.S., &c. Newcastle: Blackwell.

As a Mineral Surveyor Mr. Sopwith has had excellent opportunities of acquiring practical geological information, and he has been no less successful in imparting it to the public. The models, which this work is intended to describe, illustrate the nature of stratification, valleys of denudation, succession of seams in the Newcastle Coal Field, the effects produced by faults or dislocations of the strata, intersection of mineral veins, &c. These models are very ingenious and useful, and the work before us besides being a necessary companion to them, is of great interest on its own individual account. The illustrations being drawn from actual inspection, and greatly to the merits of the work, which abounds in practical instruction on mining geology.

PARLIAMENTARY PROSPECTS OF THE ENGINEERING INTEREST.

A change in the administration of the country being imminent, it is the bounden duty of the engineers, both civil and mechanical, to profit by the present state of affairs to obtain redress for their numerous grievances. No time can be more appropriate than the opening of a new parliament to canvass for a change in the Standing Orders of the House of Commons, and the formation of a ministry is a good opportunity for securing a sound system of government policy. When we consider the vastness of the interests involved, and the extent of influence at the command of the engineers, we entertain no doubt of a relief from the oppressions by which they have hitherto been afflicted. It may not be in the power of the engineers to meet together at this season and act in concert, but it is at least open to them to exert themselves individually in influencing the members for their several towns and districts, who may be called on to co-operate in a cause, which is nonpolitical, and of the greatest importance to the industrial interests of the country. It is perhaps fortunate that Sir Robert Peel has hitherto shown himself favourable to our interests, and we think that after the formation of a new ministry under his guidance, no time should be lost in ascertaining by a deputation of men of all parties the course he intends to take upon the momentous questions of the Standing Orders, Railways, Steam Navigation and the Irish Railways, so that the engineers might be able to take their measures accordingly.

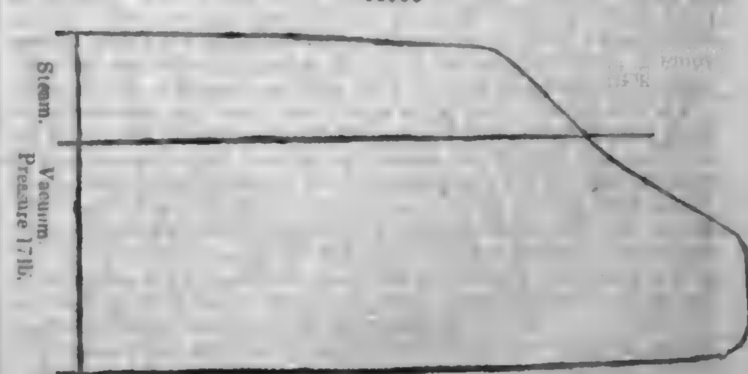
MR. JOHN SCOTT RUSSELL'S TREATISE ON STEAM NAVIGATION.

SIR—In a late Treatise on Steam Navigation, by John Scott Russell, I observed a statement regarding a steamer lately constructed on the wave-line principle, which ran thus, page 304, "the next and last vessel is the Flambeau, built in 1840, on the wave principle, by Mr. Duncan of Greenock, with the co-operation of the present writer. This vessel with the smallest proportion of power to tonnage, and with the smallest supply of steam, is nevertheless by far the swiftest vessel on the Clyde." Now I think "the present writer" ought not (although the vessel was constructed on the wave principle), to have allowed himself to go beyond the bounds of truth, I mean in the three last sentences. 1st. "She has the smallest proportion of power to tonnage." This is certainly doubtful, as you will see by the following indicator diagram, taken when at the speed of 24 strokes, (now she has many times made 27 strokes per minute), making 138 horse power; not as Mr. Russell has supposed, or rather wishes to make the world believe to be 70 only. Now taking her at 280 tons measurement, we have $\frac{280}{138} = 2$ tons per horse power. If that is the smallest, pray what may be the largest,—and yet with all this she was not by far the swiftest.

2nd. "With the smallest supply of steam." I understand the first boiler was not capable of supplying steam to the engine the whole length of stroke, so that they expanded one-third or 20 inches, as was intended, and pressed a little higher to compensate; yet so much was Mr. Russell disappointed with the speed of the vessel, that he attributed the deficiency of speed to the deficiency of steam, and accordingly with his usual tact, got the proprietors prevailed upon to put in another boiler that should follow up the steam, which they accordingly did, and pressed at about 6 or 7 lb.; the result was her speed diminished to Mr. Russell's mortification, and time, labour, and money lost to the proprietors.

3rd. "Is nevertheless the swiftest on the Clyde." With her first boilers I grant she was the swiftest last season, only when she made the 27 strokes, but this season she is not classed among the swiftest. Now this is a statement of facts, as Mr. Russell knows very well.

Cylinder 48 in. diam. Stroke 5 feet. $\frac{48^2 \times \cdot 7854 \times 14 \times 240}{44000} = 188$ horse power.



Mean pressure 14 lb.

Your insertion of the above in your useful Journal, will oblige,
Your obedient servant,
H.

August 14, 1841.

REMARKS ON RAILWAYS REPORT AND EVIDENCE.—1841.

SIR—The report of the "Select Committee appointed to consider whether it is desirable for the public safety to vest a discretionary power of issuing Regulations for the prevention of Accidents upon Railways, in the Board of Trade: and if so, under what conditions and limitations;" together with the evidence upon which such report has been founded, has fallen under my notice, and with the view of adding my experience and reflections to the general fund of information upon railways, I request the favour that you will lay the following observations before the public at your earliest opportunity.

I am an engineer of 18 years' experience in my profession, and for the last 6 years have been intimately connected with railways, principally in endeavouring to introduce into the system various contrivances by which the public safety will be increased.

It has occurred to me as a matter of great regret that the Committee was not assisted, during its deliberation, by a practical engineer fully versed in the various railway details which were brought under its consideration, a practice which is quite usual in the Admiralty Courts, by which the testimony of the various witnesses would have been checked; for it is just evident, had such been the case, the extraordinary opinions and assertions advanced by some of them, would never have been broached, as it is clear, when the questions of the Committee were directed in such a way as to convict a witness from his own testimony, the party never failed to take refuge behind some technical details, into the peculiarities of which the Committee could not follow. A striking instance of this occurs in (Question 567) Mr. Brunel's evidence, who states as the probable cause of accident, "that perhaps a pair of wheels upon a train is slightly out of gauge, being too narrow, that in passing some guard-rail they get strained, and that when they come to a part of the line which is rather wide in gauge, they get off, and the train is delayed." Now every technical man of experience knows that if a pair of wheels be out of gauge, the fault is in the construction of the spindle, for if every spindle is made with a collar or shoulder, so that the back of the boss of the wheel butts against it, a method I invariably practice, if the wheel run round upon its axle it could never get out of gauge, so that *a regulation* providing that every axle should be made with shoulders would be a very wise and proper regulation, and would apply to all railways whatever.

In another part of his evidence Mr. Brunel states that amongst other causes of accident, "a policeman immediately runs up, and stands right in the way of the tail-lamp of the train, and the next train runs into it. Now the majority of persons would say, that if the policeman had done his duty, and showed a red light, and if the engine-man had seen the red light, there would have been no accident." If the policeman, in the case of accident, received positive instructions to run back 500 yards and hold his red light, so that the engineer of the succeeding train should not fail seeing it, this precaution, one which I have invariably insisted upon, under whatever case or form of accident, is, and would always be, an efficacious and proper *regulation*.

Mr. Brunel states, amongst other minor improvements, it would be better for the wheel not to touch the guard-rail; a man who knew any thing of a railway would then have inquired the use of the guard-rail, because, this being placed purposely to guard the wheel from the point on the opposite rail, if the wheel was not governed by it, it is useless—and there is no secondary use for it, as Mr. Brunel endeavours to make it appear in Ques. 604, and so far as the use and principle of the guard-rails go, it is the same in all cases *on all railways*.

There is another observation in the same answer, so palpably in the teeth of experience, that I cannot fail here to notice it, and that is the denial on the part of Mr. Brunel that railway improvements can be made by any parties excepting by those connected with railways. It would have been a proper question following this assertion, if Mr. Brunel had been asked whether his own father was originally a block maker, and whether the fact of his not being so would have been a proper reason for Sir Jeremy Bentham declining the encouragement due to Sir I. Brunel's very admirable machinery for making blocks by machinery—or whether the illustrious Watt was an engine driver, or before his improvements in steam engines he was actually accustomed to the management of steam engines—or whether Arkwright was a cotton spinner—or Mr. James, the father of railways, previously to his conception of railway extension, was intimately and exclusively connected with railway matters—and lastly the inquiry might have been made, what improvements have been introduced, I will not say invented, by *railway* engineers since the formation of the Liverpool and Manchester Railway, and in what respect this last mentioned railway differs essentially from a colliery railway that had been formed half a century before it.

And whence does it arise that the improvement of railways, contrasts so essentially with the advances made by the great branches of trade, and manufactures, since their first introduction, but from the fact of the monopoly of the companies on the one hand, and the disinclination of railway engineers to introduce any contrivance which does not emanate from themselves, on the other: had a liberal spirit prevailed amongst engineers, and had they the judgment to select from the mass of crude suggestions offered to them, railways would have been by this time not only safe by contrast with stage coaches, but absolutely so, there is no reason why the system should not have been so formed as that, by no chance or design could an injury happen to passengers, and no one contrivance would conduce to this result more certainly and more directly than the adoption of the low carriage, upon the principle of those invented by myself, and in use upon the Greenwich Railway, and although Mr. Entwistle takes credit for the arrangements upon the Greenwich line, inasmuch as 6,800,000 passengers have been carried without the loss of life or limb to any one, he had not the candour to admit that this gratifying result is to be attributed mainly to the construction of the carriages, for the accidents from broken axles, &c., have been much greater upon the Greenwich line than upon any other in the country, and but for the low carriages, some most awful accidents would have resulted. I may here mention that the Board of Directors to which Mr. Entwistle belongs, have not only done their worst to disgust the public by the manner in which their carriages are kept, but they would have been long since abolished by the Directors but for the resistance made to that measure by the parties who are in the habit daily of using the line. This fact is one more in proof of the necessity of some supervising power to control the measures of railway managers.

The mode in which Mr. Brunel attacks the recommendation of Sir F. Smith that an engine should not be loaded beyond a certain amount, proves again the necessity that a technical judge should have been in communication with the Committee; in that case I can scarcely believe Mr. Brunel would have indulged in the same arguments. The power of a locomotive is resolvable into two elements, the quantity of water evaporated by it, and the gradients it passes over; therefore, instead of appealing to one of these elements, viz. the gradients, had Mr. Brunel included both, the proposition of Sir F. Smith would have proved a most reasonable one. Had Sir F. Smith's proposition been that the load behind an engine should bear a certain ratio with the area of the cylinders, multiplied by a certain constant, having a ratio with the average gradients of the line, it would have amounted to the very rule of every-day practice upon any railway whatever, and by making either of these ratios fully within the average working condition of an engine, he could have so defined his object as to have ensured the punctual observance of his rule by the railway companies, a rule to which no reasonable objection could be made.

The advantage resulting from massing the trains, by the average power being thus obtained from the engines connected together, is, in my opinion, a very questionable one: supposing a very heavy train has two engines a head, and that the last engine runs so *dry* as to be useless; supposing, likewise, that the train is at a considerable distance from a siding or watering place, or a station whence another engine can be obtained, the power of the engine in good order will be almost entirely absorbed in dragging the defective engine behind it, and thus, the entire load will be retarded, and perhaps dangerously so. Had each engine taken its own load, the defective engine with its load would have been alone delayed: and, talking of expense, it would have been much better economy that a disabled engine and a small load should have been left at the first siding out of Bristol, than that a good engine should be strained and worked violently, and a heavy train delayed a considerable time throughout its journey to London, deranging all the arrangements, and endangering the line throughout. As to the maximum velocity, that could be disposed of in the way before mentioned, for the word power is resolved into the same elements, whether it be employed for draught or flight.

Mr. Brunel states "that with the best assistance of professional men, and others whose whole time and peculiar capabilities are applied to the system, we find it difficult enough to make our regulations sufficiently general to apply even upon our own line, and that the great difficulty in drawing up any code of regulations always is, to make a good regulation which is sufficiently applicable in all cases even on our own line of railway." I will prove that this very desirable system of uniformity can be easily accomplished as regards stations, and that is, to form them in such way that neither trains nor passengers shall ever cross the line. Fig. 1 will explain this method, by which it will be perceived that sidings must be placed on both sides of the line, and the crossings in such way that a train enters and departs from the siding without *backing*, backing into a siding being unquestionably most gothic and unskilful, the only apology for it being

2 U

Fig. 1.

the incapacity of the engineer to construct a safe switch and point. The passengers will enter into the offices by a bridge over or under the railway, as the case may be; it will not be out of place here to remark upon the most injudicious and unscientific practice adopted upon the Great Western Railway, in common with many others, of laying all the crossings along the line in one direction, by which means it is indispensable to back the train across the line, and bring it consequently to a dead halt twice before it can pass upon the wrong line; the apology for this is, that the peculiar switches adopted require such an arrangement, in order that the train may pass over them safely, and in the case of the switch being placed improperly, the train not being liable to be thrown off the rails. My patent switches are formed in such a way as to meet this latter case, and have this additional value attached to them, that a train may pass over them in both directions at full speed with perfect security, the switch being so made as to form a perfect and unbroken line, whether laid for the main line or cross line; my patent point or crossing is likewise so made as to require no cut in the line, nor a guard-rail in the main line; both these contrivances are in use, and when they are more generally known, the practice under discussion will be, it is trusted, altered.

It is likewise self-evident, that if sidings of this form be placed at intervals along the line, swift trains may pass slow ones with perfect facility by the slow train entering the siding, and leaving the main line open to the fast train; thus neither train need stop, nor would there be any further delay than a slight retardation of the slow train whilst the switches were altered; but supposing a man kept on the ground on purpose to effect this alteration of the switch, there would be no necessity to reduce the velocity of either train.

Here, again, therefore, a very general and very judicious regulation might be introduced applicable to all railways.

Admitting the deep interest which railway engineers *ought* to have, and the deep breeches-pocket interest which railway directors *must* have in the perfect working of railways, there is another interest which the Committee was not, perhaps, aware of operating most powerfully against the introduction of improvement, and that is the jealous and selfish feeling of engineers against adopting the contrivances of a contemporary, however useful such contrivance may be, their interest is to let well alone, and to keep without censure.

It is surprising it did not occur to Mr. Brunel that in the case of a public officer recommending to one company the adoption of a valuable improvement made by another, the two parties would be in the same relative position in the event of the compliment being returned, by the first being required to reimprove its own improvement, because, if it were proper in one company to go to an expense to effect a certain object, it is still their duty and interest to incur expence to perfect their arrangements; perhaps he may not be aware how large a comparative amount of profits is sunk amongst manufacturers to perfect their processes, when the spur of competition urges one man to surpass his neighbours, but in the case of railways the same feelings do not operate, which is the most powerful reason of all others why this want should be supplied by the interference of the legislature.

I agree with Mr. Brunel that buffers are matters of secondary importance, and I hold them only useful to protect the carriages from injury when they are knocked about in the station; for any purpose of benefit to a train when in motion, I never could discover, inasmuch as the action and reaction of the engine and trains is fully provided for by the springs connected with the drag links, in fact, were carriages provided with merely two springs acting in reverse ways, so that when the carriages are arranged in trains, a buffer spring connects one end of the links, and a drag spring the other, and supposing the link inflexible, the most perfect ease would be produced in the carriage, and every provision made for any sudden retardation to which the carriage will be subjected. However, a buffer is a buffer, whether formed by springs or hair, or by any other elastic means.

Had Sir F. Smith been simply a man of invention, without any connexion with the Board of Trade, and had he not the means of making his suggestions respected, his treatment from railway companies and railway officers would have been the very reverse of that he has found it, and the fact that his suggestions are treated with respect is a most powerful reason that the public supervisor should be the vehicle through which suggestions should be made, otherwise my experience and that of numberless other men prove that their thoughts and their time will be exerted in vain, in fruitless appeals to railway companies or their agents.

Mr. Brunel's objection to the 15 minutes interval is fair and well-considered; such an arrangement is wholly impracticable, and if adopted might lead to accidents in another point of view than that stated: a train might break down a few minutes after it had left a station, the guards and engine-men might be killed or disabled, then supposing the night dark or foggy, the succeeding train would run upon it, and very sad results would ensue; but if signals such as I have contrived were adopted, and which have been since ably recommended by Sir George Cayley, formed in such a way that the engine should make its own signal, and leave notice a mile behind it, whether it had passed or not the next signal post a mile in advance; the engine man would be thus certain of being informed of the state of the line in advance, and supposing any disarrangement of the signal, no delay or embarrassment would arise beyond the caution necessary in proceeding a mile forward, or perhaps one or two minutes in that distance. This objection is, I conceive, conclusive against any signals acting by time, as it would most infallibly fail at those times it was wanted, viz., in cases of accidents in bad weather. Whilst upon the question of signals, I cannot but advert to the evidence of Mr. Entwistle on this subject; that more accidents have not happened upon the Greenwich Railway is indeed a most providential circumstance; what would become of the trains in the case of a foggy night, with a bleak driving storm of rain or snow and wind from the north-west, and what security would there be that the men would hear the approach of a train and pass it, supposing a Croydon train was coming from London, time enough for either the Croydon train to pull up, or the Greenwich train from Greenwich to do so, or both; because, assuming that Mr. Entwistle's 15 men were most advantageously disposed of, placing 5 men from the junction towards London, and 5 towards Greenwich, the other 5 towards Croydon, the men on the London side would have to pass the word 400 yards towards Greenwich before the Greenwich train could be advised, and then either the one or the other would require to be brought to a dead halt within 200 yards, or a collision would ensue. I very much doubt whether Mr. Entwistle would not have been puzzled had the question been put to him, when was the last occasion that he was aware that this plan had been adopted, and how many times since he had been a director of the Greenwich Railway?

My experience tells me that if Mr. Brunel employs a break to his tender and engine-wheels of sufficient power to drag or stop the wheels, he will very soon destroy both the wheels and engine and railway. If any one thing has been settled in the management of a railway, it is this very fact, that, to block the wheels is to wear a flat place in the circumference, which, whenever the break is applied, allows the wheel to revolve until this flat place comes in contact with the rail, and which, by every successive operation, becomes worse, then, when the break is released, the flat side strikes the rail with a violent blow, and to such an amount that I have known one case on the Greenwich line when nearly a dozen rails were broken, on one occasion, by a bad wheel, the cause of which arose from this most vicious practice; if, therefore, Mr. Brunel realizes his notion, he will have good reason very soon to alter his plan. It is unquestionably a good plan that a large rubbing surface should be opposed to the momentum of the train, but that this should be sought, not by blocking, destroying the wheels, but by an independent method, similar to that I have already patented, and published in your Journal.

Mr. Brunel's opinion of the class of men for engine drivers, and his disposal of book principles amongst them, is most excellent, both in its substance, and in the way he defines it. I cordially and fully assent to all he says on the subject, and only wish, for his own reputation, he could always see his position as clearly and state it as cleverly as he has done in this instance.

In thus fully and freely criticising the evidence of Mr. Brunel, I trust that gentleman will do me the justice to believe that the importance attached to his opinions is my apology for subjecting those opinions to rigid review, and the object of the Committee, viz. to provide for and secure the public safety, renders it a duty of every well-wisher to railways to use his best efforts to assist such object. I purpose continuing my observations in your next paper; meanwhile

I remain, Sir,
Your obedient servant,
W. J. Curtis.

15, *Stamford Street, Blackfriars Road.*
July 22.

REMARKS ON MR. BARRETT'S OBSERVATIONS ON BARS, &c.

Sir—I have read in the July number of your Journal some observations by Mr. Barrett, on Mr. Brook's New Theory of Bars. Not having had time to peruse the work of the latter gentleman, I shall not presume as yet to form any opinion upon it; nor do I mean at present to make any remarks on Mr. Barrett's paper further than relates to a particular passage. Mr. Barrett says, "at the Neva, Gulf of Finland, the Narva, Dantzic, the Danube, the Nile, and many other places, the current without intermission (there being no *flood tide*) is perpetually running out at the rate of six, seven, or eight knots per hour, and yet the old entrances to these rivers have been blocked up by impassable bars, &c."—On this passage I will take the liberty to observe in the first place, that it presents one among too many examples of the confusion arising from hasty writing. Thus the names of rivers are mixed up with those of places in a way to render the writer's meaning rather doubtful. I presume, however, Mr. Barrett means to say—the Neva, at its effluence into the Gulf of Finland, the Narova, (not the Narva, which is a town) also at its egress into the Gulf of Finland, the Vistula (not named) at Dantzic, the Danube and the Nile at their entrance severally, into the Black Sea and into the Mediterranean.

And again, when Mr. Barrett says, "the currents of these rivers (at their embouchures understood) is perpetually running out at the rate of six, seven, or eight knots per hour, there being no *flood tides*," we are at a loss to understand whether the six, seven, or eight knots, refer severally to any three of the five rivers, and, if so, to which respectively, or whether the writer means that each of the five rivers has a current constantly running out without impediment, at the rate of from six to eight knots an hour, according to the season. The latter meaning seems to be the most rational. Now, with all due deference, I would observe, that the rivers mentioned differ so essentially in their characters that their currents must be very dissimilar, as must also the quantity and the quality (as regards sedimentary matter) of their waters. As to the Neva in particular, I know not whence Mr. Barrett has gleaned the incorrect information as to the rapidity of its current; but I beg leave to assure him, on the best authority, that its ordinary velocity, so far from being from six to eight knots per hour, is 27 inches per second, or $2\frac{8}{10}$ knots an hour. I cannot state with equal confidence the velocities of the other rivers at their embouchures, neither could I point out, without taking up much more room than you have to spare, the several particulars in which the rivers mentioned differ from one another; nor is it essential to my present purpose. The point to which I would specially draw attention is this.

According to Mr. Barrett, it is the deposit, by the outflowing waters of rivers, of the debris with which they are charged, that forms bars, whether there be tide or not, and in proof of this assertion, he gives as an instance among other rivers, the Neva. Now admitting the general correctness of his views on the formation of bars, it must be confessed he has been most unhappy in mentioning the bar at the mouth of the Neva as a case in point. The fact is, the Neva, of all rivers in the world, is the least obnoxious to the reproach of forming a bar to prevent ingress; on the contrary, she does all she can to open her mouth and invite entrance. True, there is a bar, but the materials of that bar are brought *not by the river* but by the sea.

The Neva at St. Petersburg is 50 feet deep, and, having deposited all impurities in the immense Ladoga, its waters are at all times, except when a strong wind blows in from the seaward for any continuance, as clear as crystal.

The head of the Gulf of Finland narrows gradually to the very mouth, or rather mouths of the river: accordingly when a strong wind blows in from the Gulf, a sea is soon raised whose waves, being pent in, cross and break, and, with the sand stirred up from the bottom rush for escape to the open mouths of the Neva, where being met by the obstacle of the descending current of the stream (bearing along in its main stream a mass of 116,000 cubic feet of water in a second) there naturally results an annihilation of force and a deposit or bar of sand. This being the fact, I am sure Mr. Barrett will see the impropriety of bringing in the Neva in support of an argument to which it does not apply.

The truth is, a bar or deposit will ever be formed where two bodies of water meet, and one or both is charged with detrital matter; but in many cases it is the *sea*, and *not the river* which furnishes the whole of the material of the bar, and in almost every case, I believe, it brings its quota to the mass.

In conclusion, Sir, for I have already trespassed too far, I would say, the subject of bars is a most interesting and a most important one; but those who discuss it cannot be too careful in the choice of facts in support of their arguments if they would not furnish weapons against themselves.

I am, Sir, your most obedient servant,
J. R. Jackson.

P.S. As connected with the subject of bars and sand-banks, I cannot refrain from adverting to a common error which is being continually repeated by persons writing on these matters, viz., that the sand of rivers and that on the sea beach, results from the trituration of the stones rolled by the stream or agitated by the waves. Now Mr. Editor, it is physically impossible that sand can be formed in this way. Sand is an original formation, and all that running water and waves do or can effect is, to wash away the lighter matter, and leave, or carry away, and deposit the sand in particular places. Trituration in the beds of rivers and on the beach, will wear away stones and rocks and polish them, and the result will be a fine impalpable powder, but not one particle of sand will be formed in the process, were it to continue till doomsday. It is high time this egregious error was exploded, an error which could never have gained credit but for that unaccountable indolence of mind which leads so many to take every thing for granted without a moment's reflection.

J. R. J.

ON CANDIDUS'S REMARKS ON THE LECTURES OF THE PROFESSOR OF ARCHITECTURE.

Professors, whether of architecture or any other art or science, are undoubtedly public men, and as such are open to the most unlimited criticism; but, by the same rule, the critics must submit to be attacked in their turn, if any one of the public should think proper. But it should be remembered that abuse is not criticism, and that more effect will be produced by clearly pointing out errors than by the use of "damnable" expressions, which is the style I alluded to, and which will be found scattered occasionally through the fasciculi. I should not, however, have noticed it, had not Candidus been so much in the habit of boasting of his freedom of speech, which, however, by his own confession, avails but little, as it is evident he might as well "try to tickle a rhinoceros with a rose leaf" as attempt, with a one Candidus power, what it would require sixty to effect.

The possibility of treating Gothic architecture properly so as to conduce to comfort, is still unproved. I find repeated the bare assertion of the necessity for treating it with intelligence and ability, but no evidence produced to show that the greatest ability can lead to satisfactory results.

If no more was to be expected from Grecian and Roman than is to be found at the British Museum and other works by the same architect or others of his school, I should then call for Gothic or any other style to save us from such insipid abortions, which are, at any rate, as bad as facsimilies of Gothic, and much worse, inasmuch as they have been so much more often repeated; but I have a higher opinion of the resources of those styles than to believe such to be the case, and from some former remarks of Candidus, I think he will agree with me in that point at least. I shall make no comment on the preference apparently given to the spire of St. George's, Bloomsbury, over that of Bow Church; such an assertion would require more boldness than even Candidus is gifted with—it can therefore be only a mischievous insertion of the printer's devil.

Barry has taken up Gothic architecture with an originality of conception to be found in no other architect—but even his success will not warrant the assumption that we shall ever be able to incorporate the principles of the style with the habits of the present day. At the period at which this style flourished, it followed a regularly progressing course, commencing with the Norman. This was gradually improved upon till it resulted in the early English, which, by further modifications, became that of the decorated period, the most perfect of all. From that time it increased in richness and exuberance, but declined in purity till it was worn out in the reign of Henry VIII. Now I cannot see how we can, with advantage, dip down into any one

of these styles at pleasure, and follow it out in the spirit in which it was then followed, and in which is the only hope of success. It is like transporting the trees of the tropics into this country, where only the most assiduous attention can keep them alive—nothing can ever make them equal in beauty the natural growth of the trees of our own forests, though in their native climate they may as much surpass them as they now fall short.

S. L.

THE ROYAL ACADEMY.

SIR—I am very glad to perceive that painters as well as architects, are at length beginning to remonstrate against the truly preposterous system of hanging pictures and drawings at the Royal Academy. Let us hope that what has lately been said on the subject both in your own Journal, and the Art-Union, will now shame the Academy into common sense, and deter them in future from taking in more works than can be properly seen when hung up.

Of course this would contract their catalogue to about one-half its present extent—in which case it might be sold to the public at half its present price,—but both the public and artists would be benefitted by the reduction—I do not mean of the price of the catalogue, but of the dense throng of pictures and drawings, the majority of which are annually put out of sight, by being *exalted* to disgrace—to their own disgrace and to that both of the Hanging Committee in particular, and of the Academy generally.

Still it is very doubtful whether the expostulations and remonstrances that have been made will produce any effect, unless repeated from time to time, and dinned in the ears of the Academicians, until they can no longer affect to be ignorant of them. Did the matter rest entirely with the President, the evil complained of would no doubt be remedied at once, but I suspect that like some other great personages, he is no more than "the puppet in the chair," and permitted to fill it on the condition of his napping in it, and not interfering with those around him. Though those composing them may be well-intentioned and reasonable people, corporate and public bodies are almost invariably shameless, and do not scruple to do in their united capacity, what hardly one among them would dare to sanction, defend, or justify individually and personally.

In the course of his remarks, the writer in the Art-Union attributes some portion of the present absurd system of hanging pictures in our public exhibitions, to the want of better contrivance and arrangement on the part of architects who build the rooms. Herein he is partly right, but he is assuredly mistaken if he supposes that, as far as architectural appearances is concerned, any thing would be lost were the rooms to be designed in such a manner as to render it impossible to put any pictures at more than a moderate height above the eye. On the contrary, as much might be gained in point of architectural effect as of positive convenience; since it would not be at all requisite that the proportions of the rooms, as to height, should be altered, or their ceilings an inch lower than at present. All that would be necessary is that no more than a proper altitude should be allowed as the available space for hanging pictures on the walls, (which might vary in the different rooms accordingly as they are intended for small or large paintings); and from that height the architectural decoration of the upper part of the walls and ceiling should commence. By this means the general appearance would be very greatly improved; and instead of the broker's-shop and picture-dealer's-warehouse look, which now so disagreeably characterises all our exhibition rooms, there would be an air of elegance and spaciousness,—of there being room enough and to spare without *stowing away* a number of pictures, piling them up to the very ceiling, when they might just as well be poked into a lumber garret at once.

In short, let the Academy and other exhibiting Societies break up their *Lumber Troop* corps, dismiss their host of supernumeraries, and instead of surfeiting their visitors with an annual cram—consisting of a good deal of trash, give us much less as to quantity, and much more as to quality.

I remain, &c.,

COMMON SENSE.

PILBROW'S CONDENSING CYLINDER STEAM ENGINE.

THIS is a contrivance intended, according to a pamphlet written by Mr. Boyman Boyman, to save the loss of power occasioned by the imperfect exhaustion of the cylinder in steam engines of the ordinary construction, and by which Mr. Pilbrow considers that he will save *more than half* the fuel of Mr. Watt's Rotative engines. The author of the pamphlet in question, however, dispels at the very outset the illusion as to the extent of saving by stating that Mr. Watt estimated the mean resistance of the unexhausted steam at 4 lb. per square inch, in an engine loaded so as to exert its intended power, the steam being 2¼ lb. less than the atmosphere. In this case the pressure of the steam is 2¼ lb., from which deducting 4 lb. for imperfect exhaustion, and 1⅞ lb. for friction (as at page 28) there remains an effective pressure of 6·46 lb. The pressure in the condenser at a temperature of 100° is 1 lb., therefore the limit of what may be saved by Mr. Pilbrow's arrangement is 3 lb. per square inch, which is the entire loss resulting from the exhaustion in the cylinder being less perfect than in the condenser; but if the whole of this were saved, the load of the engine being increased, the friction would be so likewise, and the effective pressure would become, say 9·09 lb., and the saving of fuel would be less than 29, instead of more than 50 per cent., as anticipated by Mr. Pilbrow. It is evident that the loss in question would not rise in the same proportion as the pressure of the steam employed, particularly when it is expanded in the cylinder, which is now pretty generally done to a greater or less extent, and we are persuaded that Mr. Farey must have overrated the resistance of the unexhausted steam, where it is used at 8¼ lb. above the atmosphere, when he estimated it at 5·71 lb.; but even with this allowance the consequent loss of duty amounts to no more than 29 per cent. It should be observed that this is the *whole* loss due to imperfect exhaustion in the cylinder, which can certainly not be saved by Mr. Pilbrow's arrangement, though he considers that it is.

Little need be said of the theory of condensation, as it is called, laid down at pages 19 and 20, which is very little of a theory, and nothing at all to the purpose; but since it is dragged in, as it were, in confirmation of the advantages of the Condensing Cylinder Engine, we shall merely show that the inferences intended to be drawn from it are erroneous.

The theory of condensation is that "steam can only be condensed as fast as it rushes from the cylinder to the condenser, as far as the injection can enter, and as fast as the water, or cold surface, can absorb all the caloric of the steam." Mr. Boyman concludes that "if the vacuum gauge shows, whilst the steam is being condensed, a less mean vacuum in the condenser than what is due to a temperature of 100°," (considered by Mr. Watt as a fair average), "it shows that the steam has flowed quick enough to the condenser, and is there waiting to be condensed," and that "no increase of eduction valve would, therefore, cause a quicker annihilation of the steam, to give a better mean exhaustion of the cylinder, for it is already large enough to permit its escape as fast as a certain quantity of water can take up its caloric." But what is the just conclusion to be drawn from the above circumstance?—Simply that there is not sufficient injection water to reduce the condensement to the required temperature; a knowledge of the actual state of exhaustion in the cylinder would alone show whether the steam flowed fast enough into the condenser. Mr. Boyman harps continually on one string—the impropriety of reducing the condensement to a lower temperature than 96° or 100°, and pretends to conclude therefrom that no better cylinder exhaustion than was obtained by Watt can be achieved with the ordinary air pump, separate from the condenser.

The long discussion of the comparative performance of Mr. Watt's rotative engines and the present is irrelevant, and we shall therefore discuss it with one or two remarks.

After extracting Mr. J. S. Russell's proof of the fallacy of the opinion that the better the vacuum the greater is the duty, the author informs his readers that "the above formula is given because it confirms the general principle, that more is lost than gained by a vacuum *beyond certain limits*. It does not embrace," he says, "the principles of condensation, but has reference simply to temperature; not," he continues, "that this theory is supported by the practice of Cornish engines, where the greatest duty is performed with the greatest vacuum."

If, then, this theory is not supported by facts, how can it be said to confirm the general principle?

In speaking of the *extraordinary* Indicator diagrams of the present day, (which seem to puzzle Mr. Boyman exceedingly, because they show that Mr. Farey's observation, made 14 years ago, is not applicable to engines of the present day, namely, that "the modern engines are, by their construction, less capable of speedy exhaustion of the cylinder than the original construction"), he mentions that in the diagrams of the *British Queen*, where a mean cylinder exhaustion of 12·3 lb. is shown, the condensement is reduced to the temperature of the external water, but he does not seem to be aware that *the condensing water left the condenser at a much higher temperature*, which it must have done, or it could not have condensed the steam. It is however certain that, whatever may have been the state of the vacuum in the upper part of the condenser, where the steam from the cylinder entered it

the mean difference between it and the mean cylinder exhaustion *cannot possibly* have amounted to 2.41 lb., the external barometer standing at 30 inches, as that would indicate a perfect vacuum, which is obviously impossible.*

In Mr. Pilbrow's engine the ordinary condenser and air pump are replaced by a double-acting air-pump of the same size as the steam cylinder, called the condensing cylinder, in the interior of which the condensation is effected by injection alternately above and below the piston, which is of course solid, like the steam piston. The two cylinders are connected at top and bottom by passages, with valves to open and close the communication alternately. The action will be as follows: while the steam piston is ascending, the air-pump piston is descending, and the two cylinders communicating at top, the steam which performed the previous down stroke will flow into the condensing cylinder, and be condensed by the jet, by which, as we know from the experience of ordinary condensing engines, the vacuum above the air-pump piston will be maintained at nearly its maximum, while the exhaustion of the cylinder will be nearly the same as in ordinary condensing engines. Mr. Boyman however supposes that, "during its condensation, the uncondensed steam will keep giving to the condenser piston, until completely annihilated, just as much power as it offers resistance to the effective action of the steam piston." The exhaustion on the under side of the condenser piston will be the maximum throughout the stroke, so that the resistance to the motion of the steam piston (exclusive of friction and the resistance to the discharge of the condensement in the latter part of the stroke) will be equal to the mean pressure of the used steam remaining in the steam cylinder *minus* the difference between the maximum and mean exhaustion in the condenser, and this difference, which is quite insignificant, is, after deducting the surplus power required to work his large air-pump, the true gain of power obtained by Mr. Pilbrow's contrivance, and we think it probable that after the deduction the gain will be found to be negative, or a loss.

CARBONIC ACID GAS VERSUS STEAM.

(From "Buckingham's America.)

Towards the close of our stay in Philadelphia, I had an opportunity of attending one of the chemical classes of my friend Dr. Mitchell, and witnessing there a most interesting experiment for the rendering carbonic acid gas solid, and for producing by it a degree of cold, extending to 102 degrees below zero, on the scale of Fahrenheit's thermometer. The materials, first confined in a strong iron receiver, were, super-carbonate of soda and sulphuric acid, in separate divisions; the whole was then powerfully shaken, so as to be well mixed or incorporated, and this operation continually evolved the gas, till the whole vessel was filled with it in a highly condensed state.

An instrument not unlike a common tinder-box, as it is used in England, but about twice the size, and with a small tube of inlet passing through its sides, was then fixed by this tube to a pipe from the receiver. The inside of this box was so constructed as to make the gas injected into it fly round in a series of constantly contracting circles, which was effected by projecting pieces of tin at different angles, fastened around the sides of the interior. The gas being then let out by a valve, entered this box from the receiver, making as loud a hissing noise as the escape of steam by the safety-valve of a large boiler, and in about three or four seconds the emission of the gas was stopped.

The box was then taken off from the receiver and its cover opened, when it was found to be filled with a milk-white substance, in appearance like snow, but in consistence like a highly-wrought froth, approaching to a light paste. It was surrounded with a thin blue vapour like smoke, and was so intensely cold, that the sensation of touch to the fingers was like that of burning; and the feeling was more like that of heat than cold. The slightest particles of it dropped on the back of the hand, and suffered to remain there, occasioned a blistering of the skin, just like a scald; and some of the students of the class who attempted to hold it in their fingers, were obliged to let it drop as if it were red-hot iron.

Some liquid mercury, or quicksilver, was then dropped into a mass of this "carbonic acid snow," as it was called, mixed with ether, upon which it instantly froze, and being taken out in a solid mass, it was found to be malleable into thin sheets under the hammer, and capable of being cut up like lead, with a knife or large scissors. As it became less cold it grew more brittle, and then, when pressed strongly by the thumb or finger against a solid substance, it was found to burst under the pressure, with a report or explosion like the percussion powder.

A small piece of this carbonic acid snow was placed on the surface of water, where it ran round by an apparently spontaneous motion, and gave out a thin blue vapour like smoke. Another piece was placed under the water, and kept beneath it, when it emitted gas in an immense stream of air-bubbles, rushing from the bottom to the top; thus returning, in short, from its solid to its original gaseous condition. Some of the snow was then mingled with the well-known "freezing mixture," and by stirring these both together, a degree of intense cold was produced, extending to 102 degrees below zero, and there remaining for a period of ten or fifteen minutes; though the weather was extremely hot, the thermometer standing at 94 degrees in the shade, in the coolest parts of Philadelphia, and being at least 90 degrees in the lecture-room itself.

The practical application of this discovery to the propelling of engines in lieu of steam, was then exhibited to us. A model of an engine of the ordinary kind now in use for mines, manufactories, and steam-ships, was placed on the table before the lecturer. A metal tube was then screwed on to the pipe and valve of the receiver, in which the condensed carbonic acid gas was contained, and the other end of the tube through which the gas was to escape, when let into it from the receiver, was applied to the wheel of the model engine; the gas was then let out, and the rushing torrent of it was such as that it propelled the engine wheel with a velocity which rendered its revolutions invisible, from their speed, making the wheel appear stationary, though in a trembling or vibratory condition, and rendering all perception of the parts of the wheel quite impossible till the gaseous stream which gave the impetus was withdrawn.

Dr. Mitchell expressed his belief that this power might be made to supersede entirely the use of steam and fuel in navigation, and thus overcome the greatest difficulty which has yet impeded long voyages; he thought it might effect the same salutary change in manufactories where engines are used, so as to remove the greatest nuisance, perhaps, of all manufacturing towns, the immense quantities of smoke which darken the atmosphere, and destroy the cleanliness of places, persons, raiment, and dwellings. He founded his belief on the expansive power of this gas when brought into a highly condensed state, such as we saw it, and the practicability of bringing this power to act upon engines of any size by land or by sea. For the latter purpose he suggests the use of iron tanks, made with the requisite degree of strength, to act as receivers; these being fitted to a ship's bottom, along the keelson and the inner floor of the hold, as the iron water-tanks of ships of war are at present, it may be placed on board vessels intended to be propelled by engines, in such quantities as the length of the voyage may require; communications from these tanks, by tubes of adequate size and strength, would then have to be made to the engines, and placed under the complete control of the engineer, as the steam-power is at present. The expansive power of the condensed gas, and its pressure outward, or tendency to escape, being the same in its nature with steam, but greater in degree, the application and direction of this power would effect all that steam now does, and thus supersede the use of fuel, with its inconveniences and accidents, entirely.

In reference to the expense, Dr. Mitchell had made such calculations as to satisfy him that it would be cheaper than the present materials of steam navigation. The Great Western steamer, in coming from London to New York, actually consumed 600 tons of coal, which, at the lowest possible estimate, could not cost less than £1000 sterling, or 5000 dollars. But as it was necessary to provide for a longer voyage than that actually performed, in case of accident or delay, no less a quantity than 800 tons were taken on board, and consequently 800 tons of space were wholly lost, or rendered unproductive, by its appropriation to fuel. The expense of the requisite quantity of gas for such a voyage, including all the fittings, would not, he thought, exceed that of the coals and requisite machinery; and the saving of the space, for freight, would be a source of considerable profit; while the avoidance of the heat and smoke, inseparable from fuel and steam, the absence of boilers and chimneys, and the safety from accidents of bursting and taking fire, would be all such high recommendations to passengers, that none would venture to embark in steam-ships while those propelled by carbonic acid gas were available.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

INSTITUTION OF CIVIL ENGINEERS.

March 16.—The PRESIDENT in the Chair.

"Description of two Wrought-Iron Roofs over the buildings at Mr. Thomas Cubitt's Works, Thames Bank." By Mr. Adams.

This communication describes in detail the construction, and gives the dimensions of the several parts of two fire-proof roofs of 29 feet span, one of which bears, in addition to the covering, a ceiling of tile arches upon iron girders, the weight of which is equal to 5 tons 4 cwt. upon each truss.

The paper is accompanied by two drawings of the roofs.

"Description of a Double Telescope Theodolite." Arranged by Nathaniel Beardmore, Grad. Inst. C.E.

The improvement in this theodolite consists in its having a second telescope fixed over the ordinary one, in a reverse position, so that the line of collimation of the two telescopes when properly adjusted should be the same. The principal advantage gained is, that a straight line may be carried out with perfect accuracy, without the tedious and uncertain process of adding 180

* It may be as well to observe here that the difference between the exhaustion in the cylinder, and in the condenser is independent of the mode of condensation; and that consequently, if by any improved process the vacuum in the condenser be increased, the cylinder exhaustion must be so too.

degrees to the observed angle and reversing the instrument. A drawing of the instrument accompanied the communication.

"*On setting out Curves for Railways.*" By R. C. May, Assoc. Inst. C.E.

The method of setting out curves proposed in this communication is founded upon the 32nd Prop. of the 3rd book of Euclid. It consists in cutting off by a chord a segment of the circle to be described, and then finding any number of points in the curve by means of a reflecting instrument, which is set so as to reflect the angle in that segment.

The instrument which has been adapted by the author for this operation, consists of two plane mirrors, the upper one being fixed vertically upon a disc of brass, and the lower one fastened to an arm which turns upon its centre, and permits the two mirrors to be set at any angle with each other: the arm can be fixed by a clamp screw. In the case surrounding the mirrors are two holes, for admitting light, and between them is the sight hole, placed so as to bisect the angle formed by the mirrors. From the underside at the centre of the instrument is suspended a slender wooden rod, with a pointed end, weighted with lead.

Angles are taken with the instrument in the same manner as with the box sextant. To determine any point in the curve, the instrument when set fast is placed in such a position that the two given objects coincide in the mirrors, and the weighted rod being released by withdrawing a bolt, falls directly beneath the centre of the instrument, marking the required point in the curve.

The author presented with this paper a Reflecting Instrument, and field tables of chords and segments to be used in setting out curves by this method.*

March 23.—The PRESIDENT in the Chair.

"*An improved Plank Frame, for sawing Deals and Planks of various thickness into any number of boards.*" By Benjamin Hick, M. Inst. C.E.

The principal improvement in this machine is a novel kind of gearing for producing what is usually termed the "taking-up" or "traversing motion" of the plank during the operation of sawing.

A revolving motion is given to two pair of coupled vertical fluted rollers, by means of worms and wheels, which are worked by a ratchet wheel and catch, from the crank shaft of the machine. When a plank is introduced between the moving rollers and the fixed guides in the centre of the machine, the tendency of the motion is to draw the plank forward at each stroke, with a force exactly corresponding to the degree of resistance opposed by the teeth of the saw. By this means, the necessity of any other support or side roller to the plank, during its progress through the machine, is avoided, and any number of planks of different length, depth, and thickness, can be put through the machine after each other, without any alteration or stoppage of the work.

Several minor improvements are introduced in the general arrangement of the machine, particularly in the position of the crank shaft and connecting rod, which latter is placed in the centre of the moveable frame, occupying a space which has not hitherto been made use of in machines for cutting two planks simultaneously; and by carrying the crank shaft upon the framing, instead of having it fixed upon a separate foundation, the construction is simplified as well as rendered less expensive.

The communication was accompanied by a working model of the machine.

"*An historical Account of Wood Sheathing for Ships.*" By J. J. Wilkinson.

This communication commences with the earliest history of naval architecture, the different modes of construction, and the precautions taken for the preservation of the vessels from the attacks of marine animals.

A very early instance of extraordinary attention to the preservation of the bottom of a vessel appeared in a galley supposed to have belonged to the Emperor Trajan, A. D. 98 to A. D. 117, which was found in the fifteenth century in the lake Hemorese (or Lago Riccio), in the kingdom of Naples, and was weighed after it had probably remained more than 1300 years under water; it was doubly planked with pine and cypress, coated with pitch, upon which there was a covering of linen, and, over all, a sheathing of lead fastened with nails of brass or copper; the timber was in a perfectly sound state.

In the reign of Henry VIII. large vessels had a coating of loose animal hair attached with pitch, over which a sheathing board of about an inch in thickness was fastened "to keep the hair in its place."

It is believed that the art of sheathing vessels was early practised in China: a mixture of fish oil and lime was applied; it was very adhesive, and became so hard that the worm could not penetrate it.

The opinions of Sir Richard Hawkins, of François Cauche, and of Dampier, on the practice of wood furring, are then given at length, with extracts from their journals.

The sheathing the bottoms of ships with timber, appears to have been disapproved by these early navigators. In 1668, the officers of the fleet, then preparing under Sir Thomas Allen for an expedition against the Algerines, petitioned that their vessels might not be thus encumbered, as they were in consequence always unable to overtake the light-sailing unsheathed vessels of the enemy; the petition was granted, upon the condition that precautions should be taken by cleaning the ships' bottoms very frequently.

In 1670 a patent was granted to Sir Philip Howard and to Major Watson, for the use of milled lead sheathing; it was not, however, introduced without difficulty; nor until an order was issued that "no other than milled lead sheathing should be used on his Majesty's ships." About the year 1700 the lead was acknowledged to have failed, and wood sheathing was again introduced.

Numerous instances are given of the employment of wood as sheathing for ships in celebrated expeditions: the ravages of the worm, the accumulation of barnacles and weeds, are then described; the qualities of the wood employed for sheathing in different countries, both formerly and up to the present time, are examined, and the author, who undertook the investigation of this subject in consequence of finding how little good information existed in an accessible form, promises the history of metal sheathing in a future communication.

"*A Machine for bending and setting the Tire of Railway Carriage Wheels.*" By Joseph Woods, Grad. Inst. C. E.

The usual mode of bending tire bars was by means of swages and hammers round a fixed mandril; after being welded, they were stretched on a cast-iron block formed of two semicircular pieces hinged at one point, and wedged apart at the opposite side; the hoops being heated were placed on this block, and by repeated blows driven into close contact with the mould.

Much difficulty was experienced in thus making up tires for large railway wheels, and the present machine was constructed for facilitating the process.

One end of the tire bar when heated is wedged into contact with one of four segments of a circle, of the required diameter, upon a cast-iron table, which is caused to revolve slowly; the pressure of a guide wheel at one side forces the tire bar to warp round the segments, and to form the circular hoop required; its ends having been previously scarfed, are then welded together.

The tire is again thoroughly heated and placed around the four segments, which slide radially on the table, and are then simultaneously forced outwards by a motion of the centre shaft.

The tire being slightly chilled, and assisted by the swage and hammer, soon adapts itself to the segments, and forms a circular hoop instead of two semi-circles irregularly joined at their points of contact, as by the old system; it is then ready for being chucked on the lathe, and bored out before shrinking on the wheel.

It is apparent that a machine of this description becomes applicable to tires of any diameter, by having three or four sizes of segments adapted to the table. It is found to diminish the manual labour, and to prepare the tire more accurately than by the usual process.

A model of the machine, and a detailed drawing of the several parts, accompanied the communication.

"*On the improvement of the Roads, Rivers, and Drainage, of the Counties of Great Britain.*" By Robert Sibley, M. Inst. C. E.

The author had on a former occasion drawn the attention of the Institution to the subject of a Bill before Parliament, "for the better regulation and general improvement of the Drainage of the Country;" and at the same time pointed out the course pursued by the magistrates of the County of Middlesex, in procuring with his professional assistance an accurate account of the Rivers, Bridges, &c., hoping that it might lead to similar surveys in other counties.

In the present communication he investigates the nature of the works which each county may be expected to undertake, and the means of accomplishing them economically, so that real public benefit may accrue.

The objects principally requiring the attention of the county magistrates, he considers to be, First—Facility of intercourse by the improvement of the roads, bridges, rivers, and canals. Secondly—Protection from injury by the passage of the waters from or through the county; and Thirdly—The removal of causes tending to vitiate the atmosphere, or to render unwholesome the water used for the support of human life.

All these points, which do not appear to have been fully comprehended in the Sewage Acts, are examined at length, and suggestions are offered for their regulation, with examples of the effects resulting from their neglect.

The advantage of placing the water-courses of the country generally under a well regulated system of management, is insisted upon as the most effectual mode of guarding against the destruction of property, and not unfrequently of human life, which ensues from the effects of sudden inundations, such as have recently occurred in the county of Middlesex.

March 30.—The PRESIDENT in the Chair.

"*Description of a new Universal Photometer.*" By Dr. Charles Schafhaeutl of Munich, Assoc. Inst. C. E.

The inadequacy of the photometric instruments invented by Pictet, Rumford, and others, is universally acknowledged. The bromide of silver, as used by Sir John Herschell, although extremely sensitive, is only slightly affected by artificial light.

These circumstances induced the author to complete the present instrument,* which he contemplated about twelve years since.

* This paper, with enlarged field tables, has been published by the Author, with the permission of the Council of the Institution, to accompany the instrument.

* The instrument was constructed by Mr. E. M. Clarke, 428, Strand.

The intensity of the undulations of gaseous fluids, as well as that of the air, is proportional to the amplitude of the oscillations, or more properly to the square of the amplitude.

A wave of light striking the retina must create a similar vibratory motion in the nerves of the retina, because the velocity of the molecular movement of the nerves depends upon the force with which they have been struck by the original wave, and if this velocity could be measured, it would show at the same time the intensity of light.

It is scarcely possible to obtain a direct accurate measurement of this velocity, but if the time during which the vibratory motion of the nerves ceases, be ascertained, the velocity of the vibrating molecules, and therefore the intensity of light, may be determined; because the duration of an impression on the retina is dependent on the resistance which the molecules of the nerves oppose to every force striking them; but as this resistance of the nerves increases as the square of the velocity, four times the momentum or intensity is necessary to double the time of duration; or, in other words, the intensity of the pencil of rays is as the square of the time of the duration of that impression made on the nerves of the retina.

The new photometer consists of a brass bar fixed vertically in a stand, carrying at its upper end a small tube in two parts, which may be lengthened from 5 to 10 inches if requisite. This eye tube has at each end a sliding plate pierced with holes of corresponding diameters. From the bottom of the bar a projecting arm sustains the lower end of a strip of rolled steel 18 inches long, $\frac{5}{10}$ths inch broad, and $\frac{1}{32}$nd inch thick; this has at the upper end a thin plate pierced with a small hole, corresponding with the holes in the sliders, and standing $\frac{1}{4}$th of an inch from one of them; upon the main bar is a prism with a slit in it, through which the strip of steel passes; this prism can be moved up or down by a rack and pinion, so as to lengthen or shorten the vibrations of the strip.

The method of using the instrument is to adjust the two holes at the opposite ends of the horizontal eye tube, so that they perfectly correspond, and do not permit any rays of light to enter, unless the plate at the extremity of the spring be pushed aside. The light to be compared is then placed at a certain given distance behind the plate, so that by bringing the axis of the hole which is pierced in it into the axis of the tube, a small pencil of light may enter the pupil of the eye. The prism is then placed at 100 of the scale on the side of the brass bar, and the steel strip caused to vibrate gently. A luminous disc immediately appears, accompanied by scintillations, which are caused by the impressions on the retina being interrupted by dark intervals: the prism is then gradually raised until the length of the vibrations of the strip being diminished, and the velocity increased, the luminous disc appears perfectly steady and clear. The length of the vibrating portion of the strip is then read off by the verniers marked on the brass rod, and compared with the whole length of the spring, measured from 100, which is considered as unity. The number of the vibrations to be computed from the found length of the spring, are inversely to the numbers of vibrations of the whole length, as the squares of their relative lengths. Hence are constructed the formulæ for calculation, which are given at length in the communication.

A fresh luminous impression is made on the retina as often as the circular aperture in the screen on the top of the spring cuts the axis of the tube. If the duration of the small vibration of the nerves of the retina is shorter than the time of a vibration of the spring, a dark interval appears between the two luminous impressions. In this case the vibration of the spring is shortened until the next impression returns just as the first ceases, and therefore the dark interval disappears; then by measuring the length of the shortened spring, the number of vibrations can be computed, and from them the intensity of the light.

This communication was illustrated by a series of experiments upon different lights, with the Photometer which was presented by the author to the Institution.

"*On the circumstances under which the Explosions of Steam Boilers generally occur, and on the means of preventing them.*" By Dr. Schafhaeutl, of Munich, Assoc. Inst. C. E.

Explosions of Steam Boilers.—In this communication it is assumed, that perhaps not one-tenth of the recorded explosions of steam boilers can be correctly attributed to the overloading of the safety valve, or to the accumulation of too great a quantity of steam in the boiler. The author alludes to the degree of pressure which hollow vessels, even of glass, are capable of sustaining, if the pressure be applied gradually. He found, in repeating the experiments of Cagniard de la Tour, subjecting glass tubes of one or two inches in length, one-fourth part filled with water, hermetically sealed, and immersed in a bath of melted zinc, that they apparently sustained the immense pressure of 400 atmospheres without bursting; but if the end of an iron rod was slightly pressed against the extremity of the tube, and the rod caused to vibrate longitudinally by rubbing it with a leather glove covered with resin, the tube was invariably shattered to pieces.

Hence he concludes, that something more than the simple excess of pressure of steam in the boiler is necessary to cause an explosion, and that a slight vibratory motion alone, communicated suddenly, or at intervals, to the boiler itself, might cause an explosion. From the circumstance of safety valves having been generally found inefficient, he concludes that a force has operated at the instant it was generated in tearing the bottom or sides of the boiler, before it could act upon the safety valve.

From the sudden effect of this force, explosions have been ascribed to the presence of hydrogen, generated by the decomposition of water; but independently of the difficulty of generating a large quantity of hydrogen in such a manner, it could neither burn nor explode without the presence of a certain quantity of free oxygen or atmospheric air; and such an explosive mixture would not take fire, even if mixed with 0·7 of its own volume of steam.*

Sudden conversion of Water into Steam.—The ordinary mode of converting water into steam is by successively adding small portions of caloric to a relatively large body of liquid; but if the operation was reversed, and all the heat imparted to a given quantity of water in one unit of time, an explosive force would be developed at the same moment. For example, if a bar of iron be heated until it is coated with liquid slag, and is then laid upon a globule of water upon an anvil, and struck with a hammer, the liquid slag communicates its caloric instantly to the water, becoming solid at the same time that the water is converted into vapour with a loud report. A similar occurrence may take place in a steam boiler when a quantity of water is thrown into contact with an overheated plate, either by a motion of the vessel or from a portion of the incrustation formed on the bottom or sides becoming loosened. A sudden opening of the safety valve may, under certain circumstances, prove dangerous, or even any rapid increase of heat which would cause a violent excess of ebullition in the water.

An examination is then entered into of the respective powers of water and of steam, to transmit undulatory motion, and of their compressibility. According to Laplace, the conducting power of steam at our atmosphere and 294·1° Far. is 1041·34511 feet per second, and that of water 6030·88 feet. The ratio of these different velocities is therefore as 1 : 4·5.

In cases of a sudden explosive development of steam, the principal action is directed against the bottom or the sides of the boiler, whence, spreading itself through the water, it is finally transmitted through the steam to the safety valve; a wave created by an explosion, even at the surface of the water, would reach the bottom or the sides of the boiler, 4½ times sooner than it would affect the top of the steam chamber; but if it took place at the bottom, the time for the explosive wave to reach the safety valve would be the sum instead of the difference of both velocities. Although these relative periods of time may be considered as infinitely small, it is contended that there is sufficient delay (counting from the moment at which the plates begin to yield) to cause the rupture of the material which would otherwise have yielded by its own elasticity had the time been greater, as all communication of motion is dependant only on time.

Experiments upon Wires.—To illustrate the effect of the sudden development of an explosive force upon the plates of a boiler, the author gives the results of a series of experiments made by him upon iron wires, for the purpose of ascertaining the amount of elongation which took place before yielding under the sudden application of a given weight. The result was, that a wire which had resisted a tension of 22 cwt. when gradually applied, broke invariably, without any elongation, when the same force was suddenly applied by a falling body.

Upon Railway Bars of different qualities.—Similar experiments with railway bars showed that fibrous iron, which supported a gradual tension, broke by the sudden application of the same force; while close-grained iron, which was incapable of resisting the gradual strain, bore perfectly well that of sudden impact. These facts are worthy of consideration in the selection of iron for boiler plates, where the sudden action of the rending force is to be guarded against.

The details are then given of a series of experiments, illustrating in an ingenious model, by means of an explosive mixture of chlorate of potassa, the effects of explosions at different heights within a boiler.

Proposed Safety-valve.—A careful examination of the circumstances, and the results of his experiments, convinced the author that a simple mechanical arrangement, applicable to all boilers, might be introduced, so as to diminish the danger arising from the sudden development of an explosive force. He proposes to connect with the bottom of the boiler, by means of a pipe, an extra safety valve of a given area, loaded to five-sixths of the absolute cohesive force of the boiler plate. In the event of a sudden development of steam, the first shock would act upon the valve and open it, which would have the effect of depriving the wave generated of its destructive force, and at the same time diminish the violence of the second shock from the top of the boiler, having permitted the escape of a portion of the water from the boiler.

The apparatus for conducting the experiments was presented with the communication.

Steam Boiler explosions.—Mr. Parkes stated, that he had been occupied for several years in collecting facts illustrative of the phenomena of steam boiler explosions. These disasters could not all be referred to one cause. A boiler might be too weak to sustain the pressure within it, and a rupture would be the necessary consequence. But though the simple elastic force of the steam might thus occasionally account for the rending of a boiler, that cause was insufficient to explain many well-known phenomena, such as the projection of an entire boiler from its seat, the separation of a boiler into two parts, the one remaining quiescent, the other being driven to a great distance, &c. He was of opinion that a very sudden development of force could alone have produced such effects.

Dr. Schafhaeutl had ingeniously shown that an explosive force generated under water would act upon the bottom of the boiler and burst it, before the

* See the author's experiments, Mechanics' Mag., Vol. XXX. p. 144.

safety valve could relieve the pressure. The Doctor deduced from Mr. Parkes's theory of "the percussive action of steam," and his own experiments, that if, from any cause, such as the breaking up of a portion of crust adhering to the bottom of the boiler, a volume of steam of high elastic force was suddenly evolved, a rupture of the bottom would be the consequence, or, the boiler might be separated into two parts. Mr. Parkes coincided in this opinion, and cited several examples in support of it.

It appeared to him that a force different from, and greater than, the simple pressure of the steam, was the principal agent. The Committee of the Franklin Institute, and others, who in their experiments had endeavoured to produce explosions of boilers, had very rarely succeeded, and the effects obtained fell far short of those which continually occurred by accident. It might be safely inferred from this fact, that the experimenters had not arrived at the true cause of the ruptures and projections of boilers, otherwise the production of similar effects would not have been difficult.

Salt Pans.—Describing the sudden development of a volume of steam, from highly heated plates, which no practicable number of safety valves could discharge quickly enough to save a boiler from destruction, he instanced the effects produced by the breaking up of the scale in salt pans. Carbonate and sulphate of lime were separated from brine by evaporation, and adhered very firmly to heated surfaces. A crust of salt frequently formed upon this deposit; the cessation of ebullition (if the deposit occurred over the furnace) was the consequence, and the bottom of the pan became red hot. The manner in which the pan scale was disengaged, was to strike it with the edge of a heavy iron pricker, which allowed the brine to reach the plate; it was also frequently broken through by the expansion and bagging down of the plates, leaving the crust above like an arch. In such cases the plate was seen for an instant to be red hot, and immediately afterwards an immense column of brine was projected from the pan, the steam evidently being of high momentary elasticity. Mr. Parkes had seen a yard square of scale thus burst, the whole surface of the plate being at a glowing red heat. Had the pan been closed, like a steam boiler, he conceived that the blow of the steam on the roof, bottom, or sides, would have destroyed the vessel.

A thin copper salt pan at Mr. Parkes's works, had a hole burst through its bottom by the sudden action of steam thus generated. The spot had no doubt been previously injured by heat. He conceived that similar phenomena might, and frequently did, occur in steam boilers.

Heated Plates.—A theory has been adopted by many writers on the explosion of steam boilers, that red-hot iron plates would generate less steam than plates at a less heat. This was founded on the experiments of Leidenfrost, Klaproth, and others, on the length of time requisite to evaporate a small globule of water in a red-hot spoon. But there was no analogy between the condition of a hot spoon containing a drop of water, and that of a body of water and heated plates in boilers.

Steam of great force would instantly be produced from a thin sheet or wave of water, passing over hot plates, the molecular attraction of a drop falling a short distance upon a plate would be destroyed, and the whole be instantly converted into steam of a high momentary elasticity. The theory of the hot spoon experiment, as applied to boilers, had been demonstrated to be fallacious by Dr. Schafhaeutl in a paper published in the *Mech. Mag.* vol. xxx. No. 799.

"Union" Steamer at Hull.—The explosion of several boilers had been attributed, and Mr. Parkes thought justly, to a wave of water washing over highly heated plates. He believed that the fatal accident to the "Union" steamer at Hull was so produced. The boilers of steam vessels were not at that period so well arranged as at present, for preventing the water from flowing to one side, and leaving a portion of the top of the flues dry with the fire beneath. Under such circumstances, the disaster which occurred would be inevitable, on the vessel's coming on an even keel. Mr. Parkes was not of opinion that it required the exposure of a large area of heated metal to effect the separation of a boiler and the projection of the upper half of it; as, in this case, it was the suddenness of the action, no number of safety valves could have deprived the steam of its instantaneous force, so as to have saved the boiler. The entire circumference of large boilers had been frequently divided as clean as a pair of shears would have accomplished the work. These phenomena were evidences of a force very suddenly exerted.

Sudden actions on the surfaces of boilers arose also from other causes than the heating of plates. During the inquiry into the causes of steam vessel accidents, he ascertained that of twenty-three explosions, nineteen occurred on the instant of starting the engines, or whilst the vessels were stationary; three only whilst the engines were at work: the greatest number took place at the moment of admitting the steam upon the piston. He attributed this effect to the steam's percussive force, which would be as much felt by the boiler as by the piston; if the boiler was weak, and, distended by steam to nearly the bursting point, the shock would be sufficient to cause its rupture. Mr. Parkes then gave several instances of such occurrences.

Steam Vessel explosion at Norwich.—In 1817, the boiler of a steam vessel at Norwich burst, and killed many persons. Previous to the accident, the boiler leaked in several places; the steam issued copiously from the safety valve, which was evidently very heavily loaded. The engine had scarcely made a revolution before the explosion occurred. By applying the present state of our knowledge to these facts, he felt assured that the steam's impact on the piston had been the immediate cause of that accident.

Explosion at Passy.—In 1826 or 1827, Mr. Parkes witnessed the effects of an explosion, a few minutes after its occurrence, in the neighbourhood of his works, near Paris. The boiler was of wrought iron, 6 feet long by about 2 feet 6 inches or 3 feet diameter. By his advice the owner had previously put in a new end, formed of one piece of hammered iron, and he was strongly dissuaded from overloading his engine, or using habitually such enormous pressures. The cylinder of the engine was horizontal, and was connected with the boiler by a short pipe and cock. The proprietor informed him, that finding his machinery working too slowly, he went into the engine-house and stopped the engine. He held down the lever of the safety valve, and on turning the cock to start the engine, the explosion instantly occurred. The new end of the boiler, which was opposite to the engine, was found separated from the body, and lying in the flue. The line of rivets and a complete ring of the new end remained upon the body, apparently little forced, and the faces of the fractured ends were as sharp and clean as if cut by a chisel or shears. The boiler, engine, and masonry, were driven into the yard in the opposite direction to the escape of the water and steam; thus, though the entire end of the boiler was removed, and the whole contents evacuated, it acted too late as a safety valve.

Explosion at Camden Town.—He observed similar effects last year in an explosion at Camden Town, being fortunately on the ground to investigate it before much change had been made. Two boilers were set end to end with a chimney between them. The end of one was blown out, and was lying close to its original seat. It was forced backwards into the chimney, which it partly supported on a pipe flange, and pushed the other boiler and entire masonry in a horizontal direction fully two feet. He considered that the percussion of the steam from its re-action against the opposite ends of the boiler in the act of tearing it off (which was the effect in this case) produced the recoil. In this case there were upon the boilers (which were connected together) two safety valves in good order, and not heavily loaded. The accident occurred during the breakfast hour, whilst the engines were not at work. One of the two stays which originally held the fractured end of the boiler, was found to have been previously broken, as its separated ends were covered with old lime scale—the other had evidently been long cracked, and was only held by a fragment. The fractured end of the boiler was not exposed to the fire, nor did the shell or the flue within it exhibit any marks of injury from fire or from dislodgment of scale. The steam, in its effort to escape, acting first against one end, not only raised the boiler from its horizontal position to an angle of about 45°, but gave it a twist obliquely from the line of its bed.

High and low pressure.—Mr. Parkes could not agree in the often expressed opinion, that what are called high-pressure steam boilers were more dangerous or more liable to explode than others. Much depended on care and management. He believed that he was in possession of accounts of nearly all the explosions which had occurred in Cornwall since the expiration of Mr. Watt's patent, when higher pressures began to be used, and they amounted only to five or six instances, exclusive of some cases of collapsed flues. More explosions had occurred in a small district round Wednesbury during the present year with low pressure boilers, than in Cornwall in forty years, where the highest pressures were employed. He believed also that the coal districts of Northumberland, Durham, and Staffordshire, would furnish more cases of these disasters from boilers both of high and low pressure, than all the rest of England put together.

The coal districts.—When the practice in the coal districts was contrasted with that of Cornwall, the explanation was simple. Where coal was so cheap, the quantity used was unlimited, the negligence was great, and the allowance of boiler was small for any given sized engine, as enough steam could be raised by fires of greater intensity—the rule there being, to save in the first cost of the boiler; in Cornwall, on the contrary, the object was to insure economy in the consumption of fuel; consequently, all that class of accidents arising from injury to plates by fire and deposit, would be in about the ratio of the intensity of the combustion.

Notwithstanding the bad practice generally prevailing in the coal districts, there were some exceptions. At an iron work near Dudley, there were boilers now in good order after nearly thirty years' use, having required but trifling repairs during that period. In those boilers the plates of the bottoms which were exposed to the fire were all made of hammered, not of rolled iron—the boilers were large for their work, and were cleaned thoroughly every week.

Hammered plates.—Tilted plates were alone used for salt pans in those parts where the heat was most intense. Though continually heated to redness, and distorted by the action of the fire, the quality of the iron in plates thus formed did not appear to be deteriorated, for when taken out the smiths used them for making rivets, nails, &c. Rolled iron plates would do for making coarse salt, which required a heat below ebullition, but they were quickly injured when used for fine salt, and were useless when taken out.

Explosion at Essonne.—Mr. Parkes then adverted to several other remarkable cases of explosion. It was a well authenticated fact, that a boiler belonging to Messrs. Ferey, at Essonne in France, exploded on the instant of opening the safety valve.

Explosion at Lyons.—Three successive reports were heard when Steele's steam boat boilers exploded at Lyons, indicating that they did not burst at the same instant. Now, though Mr. Steele had fastened down the safety valve to increase the pressure of the steam, yet the explosion of the first boiler should, according to the received opinions, have acted as a safety valve to the second and third, and have saved them—for, by the destruction of the first boiler, the pipes would be broken, and a free exit be afforded for the steam in the others; nevertheless, they all three burst in succession. Several similar

instances of successive explosions had occurred in England. He would not at present enter upon an explanation of what he considered might have occasioned these phenomena, but he would express his conviction that the practice of suddenly opening and closing the safety valves was extremely dangerous. To be useful as escape valves, they should be allowed to open and to close in obedience to the steam's pressure only, not to be handled more than was absolutely necessary.

None of the theories yet advanced appeared clearly explanatory of the cause of the projection of heavy boilers from their seats, when in many cases they contained abundance of water. He instanced a case in which a boiler exploded, and carried to some distance a boiler connected with it, and in which some men were at work. The boilers separated while in the air, and the one which exploded attained a very considerable height, although it was 28 feet long by 6 feet diameter. The particulars of this explosion were furnished to him by Mr. Clarke, engineer to the Earl of Durham, but they could not be properly appreciated or explained without the drawings and description.

Explosion at Durham.—A boiler weighing about $2\frac{1}{2}$ tons was projected from its seat at Messrs. Henderson's Woollen Factory at Durham, in 1835; it ascended to a considerable height, and fell 300 yards from the place where it had been seated.

Crenver Mine.—A cylindrical boiler exploded at the Crenver Mine in Cornwall in 1812. It passed through the boiler house, and opened itself in the yard outside, where it was described to have fallen "as flat as a piece of paper."

Facts of this nature were replete with interest, and should lead engineers to the consideration of causes and remedies.

Boilers red hot.—Mr. Parkes then instanced several cases of boilers which had become red hot, and had not exploded; one example was a set of three boilers, the tops as well as the bottoms of which were red hot, in consequence of the house in which they were fixed being on fire; yet they did not explode. No water had, however, been pumped into the boilers whilst so heated.

Explosions of hydrogen gas.—He was in possession also of several curious examples of ruptures and projections of vessels arising from causes very different to the foregoing. One case occurred in February 1837, at the Works of Messrs. Samuel Stocks and Son, in the Township of Heaton Norris, near Manchester. The boiler was 20 feet long, 9 feet wide, and 10 feet deep, and weighed about 8 tons. On a Saturday night the water was blown out of it through the plug-hole at the bottom, by the pressure of the steam, the manlid not being removed. On Sunday evening the fireman proceeded to take off the man-hole cover to clean the boiler; on entering it with a candle and lanthorn, a violent explosion occurred; and the man was projected to some distance and killed. On examining the boiler it was found quite dry, no fire being alight, no traces of water near it, and it was quite cold: it had been lifted from its seat up to the roof, which it destroyed, and the walls of the building were thrown down. There was no difficulty in accounting for the presence of a combustible gas, as hydrogen might be evolved from the decomposition of the steam (which would remain in the boiler after the expulsion of the water) by the heated sides and bed of the boiler, and the atmospheric air which entered through the plug-hole or through the man-hole, when the lid was removed, was sufficient to form an explosive mixture. The projection of the man was the simple effect of firing the gas; but to account for the entire boiler being carried from its seat, was more difficult. The figure of the boiler after explosion exhibited two distinct actions; the ends and sides had evidently been bulged outwards by the force of the explosion within it, and the bottom had been crushed upwards by the force which raised it from its seat.

Mr. Parkes thought the circumstances admitted of a satisfactory explanation, but would not then enter upon it, as it involved the history and phenomena of projections of vessels from their beds with a vacuum within them, which he thought would be better understood after the reading of his paper on the "Percussive Force of Steam and other Aeriform Fluids," then in preparation for the Institution.

The foregoing case of the formation of hydrogen gas in a boiler, after all the water had been evacuated, was confirmed by one which took place in a similar manner at the Sugar-house of Messrs. Rhodes and Son, in London, of which all the particulars had been furnished to him by Mr. Henrickson, the manager. A man entering the boiler with a candle and lanthorn to clean it, was projected to a great height. No rupture of the boiler took place, as the quantity of hydrogen seemed to be comparatively small, and to be confined to the upper portion of the boiler, but a series of detonations occurred, like successive discharges of cannon.

These two remarkable instances showed the importance of attending to minute circumstances in the management of boilers. The practice of completely blowing out boilers whilst the flues were intensely heated, was evidently dangerous, nor should it be done without removing the man-hole cover.

Mr. Parkes felt that these notices of explosions were very imperfect without drawings, and reference to documentary evidence, but, as the subject had been brought before the Institution by Dr. Schafhaeutl, he hoped that they would be received as contributions to the stock of knowledge, and as illustrative of the precautions to be observed by attendants on steam engines.

Mr. Seaward was glad to find the idea of the explosions of boilers arising from the formation of hydrogen gas, so successfully combated by Dr. Schafhaeutl and Mr. Parkes. He perfectly agreed with the former in his opinion of the causes of the majority of explosions. In all that he had witnessed the effects of, the lower parts of the boiler appeared to have suffered most.

He was at the Polgooth Mine immediately after the explosion there, when seventeen persons were killed. In that case, he was told that the boilers were moved a distance of 7 or 8 feet from their seats, before any detonation was heard.

At the Huriam Mine (which Trevithick had undertaken to drain for a certain sum) an engine with a cylinder of 40 inches diameter was erected immediately over the shaft. Its power was not sufficient for the work required; the pressure of steam was therefore gradually increased as the depth became greater. At length the boiler, which was of an immense length, was observed to have a constant tremulous or sinuous motion at each stroke of the engine, and eventually it exploded.

Boilers in London.—It appeared that there were fewer explosions of boilers in London, in proportion to the number employed, than in any other district. One reason for this might be, that fuel being expensive, it was used economically, by maintaining a slow rate of combustion, and a regular supply of steam, avoiding the intense action of the fire, which, in the event of the engine standing still for a time, had a tendency to produce an explosion.

Mr. Parkes attributed the small number of explosions of boilers in the vessels on the Thames to the practice of allowing the steam to act upon the safety valve, instead of the engineer lifting it when the engine was stopped, as on board vessels in the north. The sudden closing of the valve had in many cases produced an explosion.

While on this subject, he felt it necessary to comment upon what he considered fallacious reasoning of Tredgold on the formation of hydrogen gas in boilers.* The passage he alluded to was couched thus:—"Hydrogen gas may be, and frequently is, formed in steam boilers through the water being in contact with a part of the boiler which is red hot; and it seems to be regularly produced during the formation of steam at very high temperatures." Dr. Schafhaeutl had shown, that the effect of water coming suddenly in contact with a part of the boiler which was red hot, was only to disengage instantaneously a large volume of steam of very high elasticity. Mr. Parkes contended, that an instance of the sudden production of hydrogen gas in a boiler under such circumstances was unknown, and he much doubted the possibility of such an occurrence. Again, allowing such an event to be possible, an explosive mixture of gases must be formed before the boiler could be destroyed; and this could not take place so long as a sufficiency of water was present, from which any considerable quantity of steam could be generated.

Mr. Donkin did not entirely agree as to the non-formation of hydrogen in boilers under peculiar circumstances. He conceived the explosions which occurred in iron founderies, on the contact of the melted metal with wet sand, to be analogous. He believed, that when water was thrown suddenly upon red-hot plates, decomposition did occur.

He had once examined a wagon-shaped boiler which had exploded; the top was thrown to some distance, and the bottom was depressed throughout its entire length. He believed, that by intense firing the water had been nearly all evaporated; the bottom had then become red hot, the pressure of the steam had forced the bottom downwards when weakened by the heat; the water on each side then suddenly flowed on to the heated part, and an explosion instantly occurred.

Mr. Seaward had known instances of the internal tube of a boiler being collapsed without any injury to the external part or body of the boiler. He had always ascribed such occurrences to a deficiency of water; but Dr. Schafhaeutl's explanation of the rapid transmission of force through the wave to the bottom would sufficiently account for the effects which had been observed.

Mr. Donkin believed, that in almost every case the unequal pressure upon the exterior of the tube, arising from its not being perfectly cylindrical, was the cause of its collapsing.

Mr. Field was inclined to attribute all the explosions which he had witnessed to simple pressure.

When steam, or a small quantity of water, was suddenly admitted into a dry heated vessel, hydrogen gas was readily formed. He had made several sets of apparatus for the purpose. A strong wrought-iron tube was heated, and, being filled loosely with fragments of iron-turnings, steam was introduced and the gas was rapidly evolved.

He agreed with Mr. Parkes in condemning, generally, the fallacy of the opinion of Tredgold, previously mentioned, as to the formation of hydrogen gas. Still, in a large boiler, almost dry, and of which a portion was red hot, he conceived, that on the admission of a small quantity of water, hydrogen gas might be evolved.

Elevation of boilers from their seats.—The President was unwilling that this conversation should terminate without endeavouring to explain the cause of the elevation of the boilers from their seats. In his opinion, this might be satisfactorily accounted for by the action of atmospheric pressure.

When an explosion took place in a boiler, a considerable body of highly elastic fluid was disengaged; a partial vacuum was thus created above the boiler, whilst the full pressure of the atmosphere was exerted beneath it. This would cause the boiler to rise from its seat, provided the atmospheric air did not at the same instant rush into it, in which case the bottom would be pressed downwards, and the upper part being torn asunder, as had been described, would then rise into the air with the elastic fluid.

* Tredgold on the Steam Engine, vol. i. p. 251. Edition by Woolhouse.

When it was considered that the superficial area of these boilers was about 60 square feet; that the pressure of the atmosphere was nearly 1 ton per square foot, and that the weight of the boilers was only 8 or 10 tons, it would be apparent that the cause was quite adequate to the effect, with a very partial vacuum or inequality of atmospheric pressure. The case was analogous to those in which light bodies were raised into the air by whirlwinds.

He referred also to two cases of an equally uncommon nature, which had lately come under his notice professionally, and which he considered to arise chiefly from inequality of atmospheric pressure.

The first occurred at the Plymouth Breakwater during the great storm in the mouth of February, 1838, when several of the largest granite blocks, weighing from 3 to 8 tons each, composing the surface or pavement of the breakwater, which, although squared and dove-tailed into the structure, and embedded in excellent cement to the extent of their whole depth, and thus forming a solid mass, were torn from their positions, and projected over the breakwater into the Sound. He attributed this to the hydrostatic pressure exerted beneath the stones, at the moment when the atmospheric pressure above had been disturbed by the masses of water suddenly and rapidly thrown upon the surface of the breakwater. Blocks of stone were thus often carried to a great distance, not so much by the waves lifting them, as by the vacuum created above them by the motion of the water, which exerted at the same time its full pressure from below.

The other case occurred during a storm in the year 1840, when the sea door of the Eddystone Lighthouse was forced outwards, and it strong iron bolts and hinges broken by the atmospheric pressure from within. In this instances he conceived that the sweep of the vast body of water in motion round the lighthouse had created a partial and momentary, though effectual, vacuum, and thus enabled the atmospheric pressure within the building to act upon the only yielding part of the structure.

Signals for Railways.

A letter was read from Mr. Edward Alfred Cowper, describing some experiments on the use of maroons as signals on railways.

The maroons are either small tin cases, or cartridges of brown paper, charged with from ½ oz. to 2 oz. of gunpowder, mingled with which are 4 of "Jones's Prometheans," which are small glass tubes, each containing a drop of sulphuric acid; the tubes are surrounded with chlorate (hyper-oxy-muriate) of potassa, and are each enveloped in a strip of paper.

In the event of an accident occurring, which renders it necessary to give notice that an approaching train should be stopped at a given point, two or more of these maroons are fastened upon the upper surface of the rail by the strips of lead attached to them. The wheels of the engine, in passing over them, crush the glass tubes of the "Prometheans," the sulphuric acid inflames the chlorate of potassa, and causes an explosion of the gunpowder, which is distinctly heard by the engine driver, who immediately shuts off the steam, and puts down the break.

Mr. C. H. Gregory had permitted several trials to be made with these maroons on the Croydon Railway.

An engine was driven at full speed with a number of empty wagons attached to it, and with the steam blowing off to create as much noise as possible, yet the explosion of even half a drachm of gunpowder was distinctly perceived: he considered the invention to be practically useful.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

ELEVENTH MEETING, 1841.

Description of the existing and contemplated Railways and Machinery connected with the Granite Quarry on Dartmoor, and of the mode of working them. By William Johnson, Grosvenor Wharf, Westminster.

Dartmoor is an extensive granitic table-land occupying the heart of the county of Devon, and in which many of the rivers of this county originate. It is in length from north to south 22 miles, and in breadth from east to west 14 miles. The height of the table-land above the level of the sea is from 1000 to 1200 feet; but the surface is broken by numerous masses of rock, which run up to three, four, and five hundred feet above the ordinary level of the moor; these are ranged in short chains, or they rise in rifted blocks, or in insulated hillocks, which are distinguished as Tors, or provincially *Tors.*

The surface granite of Dartmoor, which is in detached blocks, in infinite quantity, had been employed in the neighbourhood for the ordinary purposes of building from time immemorial. Quarried granite from Dartmoor was first brought into the market about 1820 by the Haytor Granite Company. A stone tramway was constructed from the Haytor quarries on the south-eastern face of the moor to the Stover Canal, near Newton Bushel, a few miles above Teignmouth, the nearest available port at which stone could be shipped, and by this means Dartmoor granite came into the market at considerable advantage, especially as the quality of the stone is such as to enable it to compete with the best Aberdeenshire, and, for many purposes, the lightness of its tint aided by the fineness of its texture, and the almost unlimited size of the blocks in which it could be procured without defect secured it a preference. The western face of London Bridge is mainly composed of granite from Dartmoor. Dartmoor granite has also been introduced into many of the public buildings in the metropolis; amongst others the New Post Office, the Goldsmith's Hall, Fishmonger's Hall and Buckingham Palace.

The establishment of the Plymouth and Dartmoor Railway, which was completed in the year 1825, directed attention to the fine granite on the western face of the moor, by affording ready means of transport to the port of Plymouth for stone from Foggintor and other points adjacent.

The length of the Plymouth and Darmoor Railway, from Prince-town to the Tide Docks, known as Sutton Pool, at Plymouth, is about 25 miles; though the distance from one terminus to the other, by the carriage road, is not more than 16 miles; whilst a right line, from point to point, does not exceed 13 miles in length, the greater length of the railway being occasioned by windings to save expensive works, and to obtain tolerably equable inclinations upon which the trains might run down freely and allow the empty or slightly laden waggons to be drawn back without much waste of power.

The whole rise of the railway from its toll-house in Plymouth to the Prince-town terminus, by the Prisons of War, is 1350 feet; which, upon the net distance of 24 miles between those points, gives a rise of 56·25 feet per mile, or a ratio of nearly 1 in 94. The road is almost entirely upon the surface, with occasional slight cutting and filling, and a short tunnel (30 chains in length) occurs within the fourth mile from Plymouth. The wagons or trucks used upon the line consist of a platform or bed, set upon two centres, on two under carriages, to adapt them to their work and to the excessively sharp curves and irregular surfaces that frequently occur upon the line. The power used in working the line is the gravitation of the load, assisted by horses, the return being by horses entirely. Three horses draw eight single wagons, or four double ones, with from 30 to 40 tons of granite down, and take the wagons back when empty. There are at present no planes upon the line having gear worked by fixed power, or as self-acting planes.

The quarry which affords this railway its principal occupation, is worked by the Haytor Granite Company. It is situated within a quarter of a mile of the main line of the railway, from which a branch is laid into the quarry, at two miles from Prince-town, the floor of the quarry being at a level of 48 feet above the turn-out, and 1260 feet above the level of the quay at Plymouth, from which the stone is shipped.

The quarry is on the side of the Mount known as Foggintor, at from 350 to 400 feet below the summit. A gullet was first driven in horizontally, until a face of rock 50 feet high was obtained, presenting a most beautiful section of stone, in beds or layers of from eight to ten feet thick. The gullet has since been carried forward from 110 to 120 yards, and extended laterally until the bed of the quarry presents a cleared horizontal surface of nearly 4000 square yards. The benching onwards and outwards of the upper layers exceeds 2600 square yards, and the highest bench is 80 feet above the rails on the floor of the quarry. A considerable further extent of surface, beyond and above this, is uncovered of earth, and, the crust being removed, a vertical section of the granite tor is exposed, of nearly 100 feet in height.

A single blast in this quarry has been known to separate and remove 3000 tons of stone, and single blocks have been sent out weighing 20 tons, computed to contain about 250 cubic feet.

From the lower benches, in the face of the quarry, the stone has been taken up by derricks, or moveable cranes, and placed by them in the usual manner upon trucks on the railways, laid on the floor of the quarry; whilst, from the topmost benches, the stone is delivered over the side of the hill, and skidded down an inclined plane to the masons' sheds, where the operations of converting and dressing are performed, and from whence the blocks are conveyed upon railway trucks to the place of shipment.

The existing facilities for working the quarries, are now in course of further extension, by the construction of strong timber stages or scaffolds, with travelling frames, and upon the frames powerful traversing crabs, avoiding thereby the excessive labour and delay of lifting by the ordinary means of derricks and cranes. These stages rest upon the floor of the quarry in front, and run in parallel lines of 36 feet in width onwards upon the benches according to their heights, and give the means of taking up the stone wherever the blocks may be thrown out in blasting upon the different benches, and placing them at once upon the trucks on the floor of the quarry, by which they are taken to the mason's sheds, so that the quarry is kept constantly clear, and the largest blocks of stone are moved out with the greatest possible ease. An arrangement is in progress for transferring the travelling frames, with the crabs upon them, from one line of scaffold to another, by which means power may be accumulated to almost any extent upon any one stage, to operate upon blocks of extraordinary size.

Foggintor granite is at present extensively used for all the purposes to which granite has been hitherto applied. It is superior to any other in this country for steps, plinths, string and blocking courses, ashlars, pedestals, obelisks, columns, cornices, and indeed for all the purposes of architecture, because of the freedom and comparative ease with which it can be worked, being alike capable of the finest arris and of the fairest face, whether moulded or plain; whilst the purity and evenness of its colour, and the fineness of its texture in the deep beds, give it advantages not possessed in an equal degree by the produce of any other quarry in Great Britain. Foggintor granite is moreover peculiarly fitted for the more massive works of the hydraulic architect or engineer, on account of the magnitude of the blocks in which it procurable. It is in great demand for the quoin, hinge, and heel stones dock and other lock gates, for altars in graving docks, as well as for

floors and curbs of such massive constructions, and for bridge constructions in all their varieties. Indeed, notwithstanding the facilities with which the work in the quarry is performed, the extent and depth of face exposed, and the ease with which the blocks are got out of the quarry, and upon the railway, it has hitherto been found difficult to supply, with sufficient rapidity, the existing demand.

The works at the Government Yard at Devonport—those of the magnificent new graving dock now in course of construction at Woolwich—Tenby Beacon in Pembrokeshire—the Neale Memorial in the New Forest, Hants—and the Nelson Testimonial—the retaining walls of Trafalgar Square—and the new buildings of the Sun and Alliance Fire Offices, in London, are all supplied with granite from the Foggintor Quarry. Many private works in various parts of England are also supplied with granite from this quarry, and the terrace walls and their approaches in the great quadrangle of Christ Church, Oxford, are about to be restored with Foggintor granite. Indeed, the fine texture and tint of Dartmoor granite adapt it peculiarly for terraces and for the basements of buildings whose superstructure and other collateral works are of Portland stone, Bath stone, or any of the best English freestones.

An important feature in the quarry now under consideration is the great depth at which the beds already accessible lie below the surface, yielding therefrom stone of the greatest degree of compactness and strength with perfect equality of colour; whilst the horizontal disposition of the rock allows of the removal of stone of fair forms, and in blocks of the largest size. Blocks have been sent from the quarries on Dartmoor even to Scotland to supply works there with sizes which could not be procured in that country. Sir Francis Chantrey's bronze statue of King George the 4th, in Edinburgh, stands on a block of Haytor granite, and the statue of Watt, at Glasgow, by the same distinguished sculptor, is also placed on a block of granite from Dartmoor.

Mr. Rendel bore testimony to the excellence of the quality of the Dartmoor granite, and to its peculiar fitness for any kind of work. The material was extremely good, and of sufficient fineness to admit of the most delicate moulds being made for it. It cleaves freely; there is little waste, and pieces of stone of all sizes, from the smallest to the largest, can be readily obtained. He had, some time ago, taken the dimensions of a block, and found it to be 67 feet in length, 5 feet by 8 feet at one end, and 3 feet by 5 feet at the other end. If a great outlay were justified, this granite would be the cheapest stone that could be used. The President stated, that he had attempted, some years ago, to introduce this granite into the market by means of the canal, near Tavistock, and now that such facilities existed for its transport, he would direct public attention to the beautiful slabs, columns, vases, and forms into which the Aberdeen granite was worked, and express his hopes that before the British Association next met at Plymouth, there would be a large manufactory of these articles in Dartmoor granite. The beautiful porphyry of Cornwall might also be employed in a similar manner. He could mention a remarkable instance of the durability of the Dartmoor granite. A slab which had been used as a foot bridge from time immemorial had recently been removed, and on the face, which had been turned downwards, was a Roman inscription, showing it to be at least 2000 years old.—Mr. Eaton Hodgkinson, in reference to some questions which had been asked, respecting the strength of stone according to the position in which it was placed, stated that in all bodies of uniform texture the strength would be the same in whatever position they are placed, but in bodies that are laminated the case is very different. He observed a very pernicious practice to have prevailed in the construction of many of our buildings, namely, the placing the stone without any regard to the direction of its lamination. He had extended his experiments to a great variety of stone, and he found that cubes of granite when broken with the greatest care, break up at once into wedges. Some valuable experiments on the strength of granite were published in the Transactions of the Institution of Civil Engineers, but the mode in which the experiments had been conducted was not stated, and a distinction is drawn between the crushing and the breaking force; but he thought that if the experiments had been made by pressing the stone between two perfectly smooth plates a somewhat different result would have been found; the granite would have broken up at once without crushing, as was uniformly the case in his experiments. He thought it important to interpose a thin substance, as a sheet of paper, between the plate and the stone; the pressure by this means becomes more perfectly distributed. A remarkable connexion existed between the ratio of the forces of extension and compression, and the angles at which the wedges or masses would slide off when broken by pressure. If these forces were equal, the wedges would slide at an angle of 45°.—Prof. Moseley remarked that the experiments of Mr. E. Hodgkinson were peculiarly valuable, because he had not confined himself to cubes, but extended his experiments to other forms. A singular prejudice had existed in favour of cubes. The commissioners appointed to report on the stone for building the House of Commons, experimented simply on cubes, whereas rectangles would have been much better.

Dr. Lardner's *Report on Railway Constants* was read. Details of this paper were presented to the Association in the year 1839, and reported very fully in the *Journal*, vol. 2, page 383, but as the communication was then merely verbal, and the rules of the Association require a written report, the report was formally presented, and the reading led to a good deal of discussion, but no new facts were elicited.

"*Report of the Committee on Railway Constants.*" By Edward Woods.

In a preceding Report of the Committee (published in the 8th volume of the Transactions of the British Association), five various modes of ascertaining the resistance to the tractive power on railways were described, and their relative merits discussed, and a variety of experiments on one of these methods, viz., by observing the motion of a load down an incline, sufficiently steep to give accelerated motion, having been made, it appeared, that the resistance increased in a degree previously unsuspected in proportion as the speed of the train increased,—but in what ratio, was not then determined, owing to certain discrepancies due, principally, to the varying effect of the wind at the time of the experiments. The Committee have continued to conduct their experiments in a similar manner, repeating them with various sizes of trains, at various velocities, on the Sutton incline, of 1 in 89 on the Liverpool and Manchester Railway, and on the inclines of 1 in 177, 1 in 265, and 1 in 330 on the Grand Junction Railway.* The data ascertained and given in the Report are,—1, The co-efficient of gravity on the inclination of the plane. 2, The initial velocity of train at some determinate point on that plane. 3, The terminal velocity at some other determinate point on the same plane. 4, The time elapsed in traversing the space intervening between these two points. 5, The space intervening. 6, The force of gravitation. 7, The weight or mass of the train, exclusive of the wheels and axles. 8, The weight or mass of the train subject to the rolling motion, viz., the wheels and axles. 9, The radius of the wheels. 10, The distance from the centre of the wheel, to the centre of oscillation. If a body move down an inclined plane without resistance, its velocity at any given depth below the level of the point where its motion first commences, will be equal to the velocity it would have acquired by a free vertical descent through the same height. This standard velocity being compared with the observed velocity of a body moving down an incline, and meeting with resistance, the amount of that resistance can be assigned. This mode has been objected to, from the apparent inconsistencies in the results; but these may be readily explained; and the Report shows a remarkable correspondence in the motions of the same train, when permitted to descend the same plane from the same point, provided the atmosphere be perfectly calm. The usual formula is applicable to three cases of accelerated, uniform, and retarded motion; the co-efficient of gravity is greater than, equal to, and less than the co-efficient of resistance accordingly; and the requisite correction will be negative, zero, and positive, so that the co-efficient of resistance may be found in all cases. The method of determining this correction was set forth in the former Report. When the motion is uniform, the mean resistance for any particular velocity may be assigned; but when the motion is accelerated or retarded between the two points of observation, although the mean resistance may be known, it cannot be stated with accuracy, whether that mean resistance is due to the mean velocity, or to some other velocity intermediate between the limits of the initial and terminal velocities, because experience has not yet assigned the law of the corresponding increments of resistance and speed. The results which the tables of this Report present, are considered under the following heads: the determination of the friction; the additional resistance produced by increase of speed in trains of different sizes; the effect of modifying the form of the front or end of carriages, and of other changes in the external surface of the train. Three first-class carriages were allowed to descend the Sutton incline from rest four times in succession, a length of 2420 yards. It appears that the resistance diminishes until the train attains the speed of 7·58 miles per hour, after which it increases; at 4·32 miles per hour, the resistance was 6·07 lb. per ton; at 7·58 miles per hour, 5·6 lb. per ton. This remarkable and hitherto unobserved result is owing, probably, to the more perfect lubrication of the axles at the higher speed; a certain thickness or film of grease is formed between the brass step and the upper surface of the journal, and keeps the two surfaces more effectually apart; at the lower velocities, the pressure of the step upon the journal has a longer time to act in effecting the displacement of the fresh grease which has been supplied from the box, and the result is, a greater amount of friction. Eight second-class carriages were allowed to descend the Sutton incline; the friction was a minimum at 5·84 miles per hour. The following results may be deduced from the above-mentioned series of experiments. 1, The friction was least when the train was moving at the rate of about 6 miles per hour. 2, The total resistance was also least at the rate of about 6 miles per hour, notwithstanding the effect of the atmosphere at that speed. 3, The mean resistance of first-class carriages was never less than 5·6 lb. per ton; and of the second-class never less than 7·75 lb. per ton; 6 and 8 lb. per ton will represent very nearly the mean of the resistances; and these values are used in the subsequent part of the Report. The motion of these trains being observed at lower parts of the incline, where the velocities were greater than the preceding, the resistance to the train of three carriages was 8, 12, and 16 lb. per ton, at velocities of 22, 26, and 29, miles per hour respectively, and the resistance to the train of eight carriages was 11, 12, and $14\frac{1}{2}$ lb. per ton, at the velocities of 20, 25, and 29 miles per hour. Trains of 4 and of 6 carriages were impelled to the summit of the incline, and, the engine being detached, commenced their descent at the rate of 33 and 26 miles per hour. They descended through the first half of the incline with a mean velocity of 34 and 29 miles per hour, and through the latter half, with a mean velocity of 37 and 33 miles per hour. Other series of ex-

* As Dr. Lardner's paper on "the Resistance of Air to Railway Trains," (read at Newcastle, and reported fully, with diagrams, Journal, vol. 2, p. 383, was founded on these experiments, the reader had better refer to it.

periments were made on the Grand Junction inclines: and the result of the whole shows the existence of an opposing power, created at it were by the speed itself, far exceeding that hitherto suspected.

A train of eight carriages weighing 40½ tons was started down the Madely incline 1 in 177, at speeds varying from 23 to 26 miles per hour; the mean speed attained was 25½ miles per hour. The motion of the train became uniform, so that the coefficients of gravity and resistance were equal. The mean resistance of the train was 12½ lb. per ton. A train of four carriages was started down the incline at 40 miles per hour, half way down the plane the velocity was reduced to 30 miles per hour, and at the foot, it was only 25 miles per hour. Four other carriages were started at a velocity of 32·7 miles per hour, they were retarded to 22·7 miles per hour, and proceeded with this uniform velocity to the foot of the incline. The results obtained in these experiments with the trains of eight carriages are of great practical importance, this being the nearest approach to the average passenger trains. 30 miles per hour is a fair average speed, and the resistance at the speed is about 15 lb. per ton, or almost double the value of the friction only. The friction may be diminished by proper attention to the fittings and the perfect lubrication of the axles, but its reduction is of secondary importance in the economic working of passenger trains, which, from their high velocity, must necessarily bring into play large and independent sources of resistance. The resistance to trains at different speeds being ascertained, the Committee directed their attention to the effect of external configuration on the resistance. A pointed body, as a prow, was fixed successively to the front and end of a train, but the differences observed were extremely slight, and such only as would have occurred with the same experiment repeated twice over; the pointed figure, whether before or behind, exercised no appreciable influence on the rate of the train's motion, or on the resistance of which that motion is the index. Experiments were also instituted, to ascertain whether the carriages being sent with their square ends forward, instead of being preceded by an engine and tender, would affect the results, but here also there were no greater differences than might be expected in an experiment repeated twice over; and it may be fairly concluded, that the form of the front has no observable effect, and that whether the engine and tender be in front, or two carriages of equal weight, the resistance will be the same. The intermediate spaces between the carriages were closed in, by stretching strong canvas from carriage to carriage, thus converting the whole train into one unbroken mass. The results were in favour of the train without canvas, but the differences are extremely slight; it is certain that no additional resistance is occasioned by leaving open spaces between the carriages, confining the intervals to the dimensions allowed in practice.

The Committee having ascertained that the excess of resistance, after deducting friction, required for its estimation something besides the elements of the dimensions and form of frontage, and of continuity of surface, it becomes important to inquire, what is the element exerting so powerful an influence? Their former Report contains the results of experiments with wagons on the Madely incline loaded to six tons each, and furnished with boarded fronts and sides moveable at pleasure; the differences in the results attained, were then referred to the increased frontage alone. But the experiments detailed in the present Report having been made, it became probable that the increased resistance was in a great measure dependent on the general volume of air displaced; and the Committee recommend experiments to be directed, to ascertain the effect on the resistance of diminishing and increasing the bulk of trains, the weight remaining the same.

Experiments were also made with the view of determining the amount of moving power expended in working a line, and for this purpose, the character of the line, in respect of its inclines, the weight and bulk of the train, and the speed at which the load is required to be conveyed, must be considered. The first of these alone is constant, depending on the nature of the acclivities and declivities. As an abstract question of dynamics, the power expended (the resistances being supposed constant, whatever the speed) is the same for a train travelling between two points on the same level, whether the road be be level or undulating, a due allowance being made for the difference of distance traversed. On the level line of railway, the speed of travelling would be uniform, but on the undulating line it would vary. And the real question is, will the increased velocity on the declivities compensate for time lost on the acclivities? Will the average rate of speed over the whole line be different? In order to obtain some definite result on the point, it was determined to send a train from Liverpool to Birmingham and back, a distance of 190 miles. Great care was taken in conducting this experiment, and the results are tabulated in great detail; and the following remarkable inference may be drawn, that a train of 12 carriages drawn by the same engine can be conveyed over a railway whose gradients range within the specified limits, in the same time as it could over a perfectly level railway of the same length. In ordinary practice, an engine of the dimensions tried (the Hecla) would receive assistance up the Sutton, Whiston, and Warrington inclines (1 in 89, 96, and 80), but this was not the case in the experimental trip, and the train encountered acclivities and declivities not contemplated in the application of this theory. It may therefore be inferred that the opinion entertained was correct, or that trains whose weights bear an ascertainable relation to the nature of the inclines they have to traverse, may be made to traverse those inclines at an average speed equal to what the power of the engine can effect on a level, and that an ordinary train would travel over the Grand Junction Railway (the steeper inclines of 1 in 96 being excepted) in as short a time as if the line had been absolutely level.

Mr. Brunel remarked on the inapplicability of results obtained from trains running down inclines to the ordinary working of trains on railways. Many of the results given in the Report differ exceedingly from the results of his experience in the working of the Great Western Railway. The cause of this discrepancy arose from the manner in which the resistances were obtained. In the train of carriages running down an incline, each carriage is slightly pressed upon by the next behind, so that the whole train is in the condition of a train that is pushed; and it is well known that the resistance of a train pushed from behind is much greater than of the same train pulled from before, as the carriages are thrown out of square.—*Athenæum.*]

"*Remarks on the Connexion which exists between Improvements in Pitwork and the Duty of Steam-engines in Cornwall.*" By Mr. Enys.

After adverting to the admission of the truth of progressive increase of duty, it was shown that considerable changes have been made in the course of seventy years, in the methods by which water is lifted out of the mines in Cornwall; and that in comparing the duty of earlier periods, an allowance of the difference of the Imperial and Winchester bushel of coal ought to be made. The distinction between horse-power and duty, pointed out by Mr. Parkes, was alluded to; one excludes, the other includes, the friction of the pitwork; and the remarks attached to each in Lean's report, show the necessity of adverting to the different conditions of the pitwork, in an attempt to estimate with accuracy the relative merit of different engines separate from the pitwork. In an endeavour, some time ago, to trace the causes of the great variation of the duty, a small amount of expansion was observed in engines remarkable for a low duty, and the reasons assigned were, either weak pitwork—flat rods—heavy load per square inch on the piston, and old boilers—and often the joint action of the above causes. The strength of the pitwork, or of the boilers, in different cases, seems to become the limit of expansion in the engines. In reference to deficiency of water from pumps, in proportion to the calculated quantities, on which duty is founded, two causes have operated in inducing a strong belief that it is less than at any former period: 1. Greater attention to the pitwork by the managers of the mines, under whose care it is placed, to the exclusion of the engineers of the steam-engine by which it is worked; 2. The extended use of the plunger pump—the latter instantly showing the slightest defect of the packing, and allowing of an easy remedy; while the bucket pump, on the contrary, does not show the defects in the packing; and the operation of tightening it is attended with great difficulty, so much so, as often to cause the repairing to be delayed to the last moment that the pump will lift water. The first cause, though it has a tendency to decrease duty in proportion to improved water delivery, has in a still greater degree the tendency to reduce the friction of the pitwork on a given load; yet it is not easy to assign the exact values. On the whole, a reduction of total resistances probably occurs in shafts of equal depth. On the other hand, the great increased depth of many shafts obviously produces a greater proportional friction on a given load. Under these circumstances, it becomes the fairer method to select the duty of engines working the deepest shafts, for a comparison with the duty of the earlier periods, when engines were worked so differently as regards the steam. Mr. J. W. Henwood (Wheal Towan) estimates the deficiency of water delivery at 7 or 8 per cent.; Mr. T. Wicksteed (E. Holmbush) 10 per cent. water from three lifts measured and weighed; Mr. Enys (Eldon's engine, United Mines), 4 per cent., measured four strokes of the engine from one plunger lift. The absence of attention in earlier times can only be assumed from the known habits of the miner, and the absurd stories prevalent of particular instances of neglect. Another great, but almost inappreciable change, has occurred within the last ten or fifteen years, in the increase of weight in the rods for a given load; but the circumstance of the greater weight of such rods again allowed of the reciprocal action of a still greater amount of expansion in Watt's engines; and in the heavy pitwork, the accumulated force stored up at the commencement was restored at the end of the stroke; the only loss in duty arises from an increase of the friction of the necessary balance weight; because, while a direct gain is obvious, the same mean power, by a greater amount of expansion, is obtained from a smaller quantity of water expended as steam. The present form of rod, with lifts alternately, where the shaft admits of this method, was probably due to Wat, or Murdoch. Smeaton, at the Chacewater Atmospheric Engine, in 1775t seems to have effected the introduction of one rod for a portion of the shaft, and dispensed with the older practice of tying up to the arch of the beam a separate rod for each lift. The plunger pump seems to have effected another change of some importance, in the velocity with which the larger portion of water is raised. The engines are usually made to go, out of doors, at rather more than half the velocity of the in-door stroke, the piston moving in-door, from 240 to 260 feet, and out of doors from 144 to 156 feet per minute; the velocity of the plunger, or bucket, is usually four-fifths of these amounts, or 110 to 120 feet per minute. Still a portion of the water, from one-third to one-sixth, is raised at three-fourths of the higher velocity; and recently larger valves have been placed below the plunger than above, with a view of equalizing the resistance of the water on passing the valves. A few experiments of trying an engine in-doors at a very low velocity have been made, which may perhaps be extended, to determine the increase of pressure due to different velocities of water in the pumps. The column of mercury, however, only becomes the measure of the total resistances of all kinds, which are subsequently, as far as practicable, to be separated, and values assigned to each as nearly as our means of observation admit. In commencing mo-

tion, after the state of rest to which pumping engines are brought, it is possible a greater power may be employed than is required to continue it. Still the term variable load, formerly adopted by the writer of this paper, may be too strong, and the rapid action of the mercury may render it inappreciable. In an attempt to value friction by the area of the rubbing surfaces of the packing of the plungers, it appeared the unanimous opinion of many of the best pitmen, that water could be kept from escaping with less friction by means of twelve-inch packing than with nine inch packing, in a twelve inch plunger-lift—a circumstance that requires attention, not only in this, but probably under numerous other conditions. In regard to the effect of expansion on the pitwork, in producing a variable strain during the load, it was observed, that with twelve times expansion on an engine recently erected, of Watt's construction, including clearance steam, the variation was as 8 to 1 at the end of the stroke; but that in a new engine of combined cylinder, by Sims, in which the expansion after three times in a smaller cylinder in-doors, was increased about four times out of doors into a larger cylinder, and which power was converted in-doors into a constant quantity by means of a balance, the variation would be about as 2 to 1; and in Hornblower's or Woolf's, if worked with high steam, that under the condition of twelve times expansion, including clearance steam, the variation might be roughly taken as 3 to 1—that the commercial part of the question of more or less expense in engines or pitwork, would determine the relative advantages, on the whole, of each engine for lifting water from deep mines. It seems that expansion has not been carried out to so great an extent when the load is near the end of the beam, and when the enormous balance weights, usual in Cornish pitwork, are not required to be applied, though it is obvious that this condition causes less pitwork friction.—*Ibid.*

KING'S COLLEGE.

By a prospectus that has reached us of the business of the ensuing session, we perceive that, in accordance with the intimation given in our last number, the department hitherto known at this college as that of "Civil Engineering, and of Science applied to the Arts and Manufacture," is now designated the department of "Engineering, Architecture, Arts and Manufactures."

The course of instruction proposed for students in architecture is as full and satisfactory as that for engineers has been found to be. It extends over three years, and is as follows: "Mathematics; the principles of Mechanics, Hydrostatics and Acoustics; the theory of Construction; the elements of Chemistry; Mineralogy; Geology; the principles of Experimental Philosophy; Geometrical and Perspective, Ornament and Landscape Drawing; Land Surveying; Machinery; the principles and practice of Architecture, including Design and Composition, Construction and Architectural or Building Surveying."

Mr. Hosking has been appointed to the Professorship of the Principles and Practice of Architecture, in addition to his former duties, and he is to be assisted by Mr. Andrew Moseley, a younger brother of the County Surveyor of Middlesex, and of the eminent Professor of Natural Philosophy in the same College. The drawing of enrichments will be taught under the direction of Professor Dyce, of the Government School of Design, and Landscape Drawing by Mr. Cotman, who is well known as an artist, and for his work on the Picturesque Architecture of Normandy.

BITUMEN.

A new application of this material which promises to be of very great service in engineering works, has lately been successfully practised by the Parisian Bitumen Company. The new application consists in cementing large masses of rubble stone with the bitumen in a liquid state, and this has been successfully practised on a very extensive scale on the works of the Upper Medway Navigation Company in the following manner.

The river is divided into levels by weirs and locks in the usual manner. Some of those wiers are constructed at great expense of squared masonry; others are less expensively constructed, by throwing in the rubble stone of the country to the desired shape and height of the weir; it may be remarked that no care is taken in bedding the stones, or in laying them, which is performed by the ordinary labourers of the country. The bitumen is then melted and run in between the stones, and the whole forms a mass of such solidity as to resist the heaviest floods, and is perfectly impervious to water in every part, and it is supposed that it will not require one tenth of the repairs usually bestowed on weirs of the ordinary construction.

It may be noticed that previous to this material being used, the repairs after the winter floods, which are very heavy, were very great, and caused considerable interruption to the traffic.

The great advantages arising from using the bitumen in the manner described are cheapness and facility of construction—a very considerable reduction in the expence of repairs. It is evident that this may be used to very great advantage in foundations of bridges or large buildings, as forming a compact body capable of resisting any pressure, bearing any weight that may be imposed on it, and becoming perfectly solid in five minutes after being laid; it will effectually prevent vermin from getting into houses or burrowing near the foundations.

The manufacture of bitumen is now brought to great perfection by the same Company. Some beautiful specimens of tesselated pavement are being laid of different coloured bitumen, and floors of stations, churches, halls, &c., may be made very ornamental, and equally durable with Yorkshire stone, whilst it is much warmer to the feet and not more than half the price.

Presentation of a Piece of Plate to Mr. Storey, C.E.—A piece of plate value 350 guineas was lately presented to Thomas Storey, Esq., civil engineer, purchased by subscription and presented as a token of the respect entertained for that gentleman by the different parties connected with the great public works which have been completed under his superintendence. The plate was presented at the Fleece Inn, Darlington, after a sumptuous dinner to which 62 persons sat down. The service consisted of an epergne, elegantly and elaborately chased; a full-sized tureen; two do. sauce-do; four double vegetable dishes, with handles to remove, and to form eight dishes; two 12-inch salvers; four salt-cellars, gilt inside; four spoons do. to match; two gravy spoons; one fish slice; one soup ladle; two do. sauce. On the epergne, the tureen, and six other pieces, the following inscription, surmounted by Mr. Storey's crest, was beautifully engraved:—"This service of plate was presented to Thomas Storey, Esq. C.E., by a number of his friends, as a sincere though inadequate tribute of the esteem and regard they entertain for his professional talents, and private worth." Nicholas Wood, Esq., of Killingworth, C. E., presided, and John Harris, Esq. of Darlington, filled the vice-chair. In proposing Mr. Storey's health, the Chairman said—

"It has, however, been Mr. Storey's lot to extend his services beyond the immediate district. Of the great line of communication between England and Scotland—the great chain of communication—he has had the good fortune to execute a link; and I may add that it is a pretty long link. Now when I call to remembrance that it is 45 miles, I venture to say that this link will bear a comparison with any other link in the chain between London and Darlington (immense cheering). Gentlemen, I have heard only one opinion of that link; which is, that it is the smoothest and best piece of road between London and here (cheers). When I mention a "chain," I speak of the great lines of communication—the great public railways, and when I allude to the railway from Darlington, I do not refer to the various local lines which are more immediately connected with the transmission of coals; but I allude to the line between York and Darlington, which I think will bear comparison with any of the great lines that lie between this place and London (applause)."

Removal of the North Pier Light-house.—We have this week to record one of the most ingenious efforts of mechanical skill, which has ever been exhibited in the town of Sunderland. The enterprising engineer to the Commissioners of the River Wear, John Murray, Esq., who has already manifested so much ability in improving our harbour, and our noble piers, has long been engaged in erecting a new pier on the north side of the river, for the purpose of widening the entrance to the port, and this being now nearly completed, it has become necessary to remove the lighthouse from the old pier to the present splendid erection. To give our distant readers an idea of the difficulty, we may state that the height of the lighthouse is 68 feet, and its weight 280 tons. It was on Monday last, the 2nd inst., every thing having been prepared for the attempt, that Mr. Murray carried the first part of his design into execution, and actually succeeded in moving the ponderous mass 20 feet 5 inches to the northwards. The means by which this was accomplished will seem very simple when explained to our readers; but in reality great ingenuity was requisite in overcoming difficulties, which, to many persons, seemed to present obstacles altogether insuperable. Five principal pulling screws were strongly fixed to the glacis in front of the building, and were attached to chains fastened to the cradle upon which the lighthouse stands. These screws were worked by 24 men. In addition to these, there were four screws behind the cradle to assist in propelling it, which were worked by three men each; the total number of men employed on the occasion was forty. The cradle was supported on a great number of wheels, which travelled on eight parallel lines of rails, and the entrance end of the bracing was supported on slide balks. Operations were commenced at half-past three P.M., and at a few minutes after eight it was safely landed on the new pier, where it now stands, without the slightest accident having taken place. The building is now intended to be carried 150 yards to the eastward, or very nearly to the end of the New Pier, and for that purpose it will be blocked up in its present situation, until the railways and wheel timbers are reversed, which part of the work will occupy about a fortnight, when it is intended to resume the operations for its removal.—*Sunderland Advertiser, Aug. 6.*

LEGAL CONSTRUCTION OF RAILWAY ACTS AS TO BRIDGE BUILDING.

The Queen v. Walker and Another, and the Birmingham and Gloucester Railway Company.—(Di. Montpelier Street.)—This was an indictment against the Birmingham and Gloucester Railway Company for a nuisance. The bill was found at the January sessions, and having been removed into the Court of

Queen's Bench, by writ of *certiorari* obtained by the defendants, it came down to be tried on the civil side.

Mr. Serjeant Goulburn, Mr. Humfrey, and Mr. Daniel appeared for the prosecution; and Mr. Hill, Q.C., Mr. Clarke, and Mr. Spooner for the defendants.

It appeared that the company had erected a bridge for the purpose of carrying their railway over Montpelier Street, at Highgate, near Birmingham, which street it crossed nearly at right angles. The 46th section of the Company's Act of Parliament provides, "that where any bridge shall be erected by the said company for the purpose of carrying the said railway over or across any public carriage road the span of the arch of such bridge shall be formed, and shall at all times be, and be continued, of such width as to leave a clear and open space under every such arch of not less than 15 feet, and a height from the surface of the road to the centre of such arch of not less than 16 feet, and the descent under any such bridge shall not exceed one foot in 18 feet."

By the 48th section of the same act it is provided, that "whenever the said railway shall cross any public footpath not on a level, the said company shall raise or lower the said footpath so as to preserve an ascent or descent, as the case may require, of not more than one foot in 18 feet."

The span of the bridge in question over the carriage way was 16 feet, being one foot more than the span mentioned in the act, but about four feet less than the original width of the road. The company had at first intended to obtain the required height of 16 feet under the arch by lowering the surface of the road, but at the request (as was stated) of some of the neighbouring inhabitants, who apprehended inconvenience from such a declivity, they had only lowered the road about seven feet, leaving a headway of ten feet eight inches.

When, however, the bill of indictment had been found against them, they excavated the road about five feet more, but not, it appeared, sufficiently by about six inches to give the full height of 16 feet. This excavation rendered it necessary to build retaining walls of 96 yards in length to support the footpaths on each side of the carriage way, the thickness of these retaining walls being an encroachment on the original width of the carriage way till they reached the bridge. At first no provision had been made for the footpaths, but subsequently the piers of the bridge had been cut through, and the footways had been carried through them, descending under the railway by steps, and ascending in the same manner on the other side.

Mr. Serjeant Goulburn opened the case on behalf of Mr. Unett, the prosecutor, the proprietor of an estate in the neighbourhood, and contended that the company were bound to preserve the road of its original width, and had no right to contract it by means of their bridge; that the width of 15 feet mentioned in the act was a provision only applicable to cases where the road had been originally of no greater width, or of less width than 15 feet, and was the minimum, not the maximum width which the company were bound to leave; that the company were not justified in lowering the surface of the road, but ought to have obtained their height of 16 feet from the surface of the road to the centre of the arch, by taking the railway across the road at a higher level; that with respect to the retaining walls they were an encroachment upon the approach to the bridge, and were not justified by the act; and with respect to the footpaths the company had no right to contract their width where they were carried through the piers of the bridge, nor to carry them underneath the railway by means of steps.

Mr. Justice Parke, on the counsel for the prosecution calling Mr. Hornblower, architect and surveyor, of Birmingham, as the first witness, suggested that the case appeared to be a question of law upon the construction of the act of parliament, more than a question of fact, and enquired if the facts could not be agreed upon. It was ultimately arranged that Mr. Hornblower's examination should be proceeded with, as the shortest way of eliciting the facts, which were proved by him to the effect above stated.

Mr. Justice Parke then ruled:—1st. That the company were not bound to preserve the road of its former width, but had a right to contract it by means of the bridge, provided they left a width of not less than 15 feet.—2nd. That the company had a right to lower the surface of the road in order to obtain a height of 16 feet under the arch, and that they might lower the road either before or after they had built the bridge.—3rd. That the company had no right to contract the carriage way in its approach to the bridge by the retaining walls.—4th. That the company had not complied with their act by carrying the footpaths under the railway by means of steps; but as this plan appeared the most convenient to the public, and as the sloping of the footpath, in lieu of steps, would render it necessary to underbuild the houses, the court would not compel the company to alter the footpaths.

At the suggestion of the judge, and by the consent of the parties, a verdict was entered for the crown, the company entering into a rule to widen the carriage way by pulling down the retaining walls, and throwing them back into the footpath, and undertaking to lower the road still further, so as to leave a height of 16 feet clear from the surface of the road to the girders of the bridge.

The costs to be taxed by Mr. Hilditch.

The Queen v. *Same.*—This was an indictment for a similar nuisance in Highgate Place.—A like verdict was taken.—*Midland Counties Herald.*

ST. GEORGE'S CHAPEL, WINDSOR.

August 2.

For some years past the grand western window of this edifice has been considered to be in an extremely dangerous position, and very far from secure, in consequence of its bulging considerably inwards in many of its parts to the extent of several inches.

About 10 or 12 years since, the late Sir Jeffry Wyatville minutely examined the stone work of the window, and in consequence of his report it was determined it should undergo the necessary repairs under Sir Jeffry's superintendance; but, in consequence of the architect's then engagements, the repairs were not proceeded with.

The Dean and Canons, however, have just decided that the massive stone work shall be taken down, and the whole window entirely rebuilt, preserving the valuable stained glass it contains for replacement. The execution of this work, which will require the greatest care, so as not to injure some of the finest specimens of painted glass in the kingdom, has been intrusted to Mr. Blore, the architect, by the Dean and Canons.

The great painted window, over the altar, representing the Resurrection of our Saviour, divided into three compartments, designed by the late Benjamin West, and executed by Messrs. Jarvis and Forest, in 1788, has hitherto been seen to great advantage, in consequence of the three windows on the north and south sides of the west-end of the choir having been darkened (to give greater effect to the design), and painted over with the arms of the Sovereign and Knights Companions of the Order of the Garter in 1782, 1799, 1805, and 1812. The arms of each knight are encompassed with the Star and Garter, and surmounted with his crest and coronet. The George is beneath, affixed to a blue riband, on which the Christian name and title are inscribed. These six windows are to be immediately taken out, and for the darkened glass there is to be substituted transparent painted glass (containing the arms of the Sovereign and the Knights, and other heraldic devices), thus giving an air of great lightness and elegance to this part of the chapel, although, at the same time, very materially diminishing the grandeur and effect of the large painted window over the altar.

One of the windows was completed on Saturday July 31, and judging of the effect which will be produced from this one only, the alteration decided upon by the Dean and Canons will greatly improve the general appearance of the interior of the chapel. It will only require the remainder of the windows of the choir, which are now plain, to be of stained glass, to render St. George's Chapel one of the most imposing and magnificent sacred edifices in the kingdom.

The painted glass for the six windows referred to has been executed by and under the superintendence of Willemont

Except on Sundays the chapel has been closed for several weeks past, in order that no delay may take place in the completion of the work.

The splendid organ, which is considered to be one of the finest instruments in England, has just undergone a thorough repair by Gray. The old keys, which were upwards of 50 years old, and completely worn through, have been replaced by new ones, and several additions have been made to the pipes.

As soon as the improvements now in progress are completed, it is the intention of the Dean and Canons that the whole of the interior of the chapel shall undergo a complete and thorough cleansing and repair. Nothing has been done to the chapel in these respects during the last half century.

THE RIVER CLYDE.

At a meeting of the River Trust held on Tuesday, 27th July last, Mr. James Hutchison called the attention of the Trust to a matter of the last importance, viz. the extent to which the river should be widened. In the Bill which had lately passed Parliament powers had been taken to widen the river vastly beyond its present breadth, but if these powers were acted upon to their full extent, the time occupied in the operations, and the vast increase which it would cause in the expense of dredging and maintaining the extended river at the proper depth would be such as to place the Trust in a most dangerous position; and Mr. Bald had given it as his opinion that it might be productive of ultimate ruin. Mr. Bald had, however, prepared a plan of the contemplated improvements, similar to those which had been approved of in 1836, and though this plan did not widen the river to the extent which they had power to widen it by the Act of Parliament, still it must be admitted by all that it would improve the river sufficiently to accommodate the most extensive trade which could be reasonably expected to belong in after years to the harbour of Glasgow.

Mr. Bald briefly addressed the Trust, in explanation of his plans. From his remarks we learn that the width of the river from the bottom of harbour (at which it is intended to commence operations,) down to Renfrew, varies at present from 165 to 190 feet. It was his intention, however, to increase this width to 300 feet at the bottom of the harbour; to 310 at the mouth of the Kelvin, and to 325 at Renfrew Ferry; and at the same time to "sweeten" the course, or, in other words, to remove angles and jutting points, and to make the line a straight one. If the Clyde were thus widened it would be sufficient for any increase of trade that would come to it. By not going beyond this proposed width, the channel would deepen itself, and of the progress of this deepening process, they had that day an example in the arrival in their harbour of a ship drawing 17 feet water; and he anticipated, that in a few years, if the large or extended plan were not adopted, that the depth would increase to from 18 to 20 feet. He considered the proposition to increase the width of the river to 400 feet, beginning immediately below the harbour, to be most unwise, and one which he would not advise, even though the Trust might possess the means to execute it. It would take 70 years to complete the operations according to this extended plan, and when once finished the expense of maintaining it would be absolutely ruinous.

To a question from Mr. Burns,

Mr. Bald replied, that it was a law recognised by all engineers that if the channel of a river were widened beyond the proportion of its depth, it became more shallow, from the slower motion of the current. If, on the other hand, it was narrowed beyond this proportion, it had a tendency to become deeper from the more rapid motion of the stream, particularly in land floods. He instanced three places in the river, the harbour being one of them, where deposits were continually taking place, from their being unusually wide.—Were it otherwise, this silt or deposit would be at once removed by the land flood to the sea.

Mr. James Hutchison explained, that at the time it was resolved to take powers to widen the river to a great extent by the last Bill, Mr. Walker, upon making out the plans, informed them that if the breadth of the river was at any time extended according to these plans, they must make up their minds to the maintaining of it by dredging being immense.

After a conversational discussion of some length, it was finally resolved that Mr. Bald's modified plans should be adopted, and, as we understood, that operations should be commenced immediately.—*Glasgow Argus.*

STEAM NAVIGATION.

The Iron War Steamer Phlegethon.—We perceive, by the Calcutta papers brought by the India mail, that this vessel, which was built by Mr. John Laird, of North Birkenhead, for the East India Company, has arrived at that port. She is about 500 tons measurement, armed with two 32-pounders and other small guns, and is exactly the same size and model as the former iron war steamer, the Nemesis. She was to sail for China about the middle of June, to join the expedition. It was reported in the Bombay papers, that two armed steamers, the Ariadne and Medusa, both built by Mr. Laird, carrying each two 26-pounders, would be ordered to China: they would make an effective flotilla of four powerful iron armed steamers attached to the expedition, and, from the services rendered by the Nemesis, are likely to prove a great acquisition. The following extract of a letter, dated Calcutta, June 5, gives an account of the Phlegethon:—"I am too full of business to write at length just now; but you will be delighted to hear we arrived at this place on the 22nd of last month, as sound in hull, boilers, and engines as when we left England. We have had some severe trials, and a large share of stormy bad weather. The Phlegethon, in bad weather, has surpassed my most sanguine expectations, and having gone over 17,157 miles without straining a rivet, will I consider quite carry out the principle that these sort of vessels can navigate in security between England and India."—*Liverpool Albion.*

The Steam Ship "Admiral."—In these days of steam triumphs, we have frequently had to record the achievements of mechanic art, as applied to steam-ships of leviathan dimensions, as well as of the consummate skill displayed in the performance and management, and we remember few that have possessed greater claim to public attention than the splendid steamer *Admiral* now running between Liverpool and Glasgow, the same line on which the *Achilles, Commodore, Acteon, City of Glasgow,* and *Princess Royal,* all splendid steamers, are employed. The *Admiral* is a vessel well worthy of her name and lineage, and, whether the size and beauty of the ship, her excellent accommodations, or the great power and perfection of her machinery be the object of admiration, it must be admitted, that in each of these departments, she has never been surpassed. The engines supplied to this vessel are of unusual power and beauty of construction, fitted up with expansion gear, and possessing all the latest improvements: they were produced at the Glasgow Vulcan Foundry, and are of 200 horse power. It is a matter of great interest to witness the cleanliness and order always observed in the engine-room, and the great care and attention of the engineers are particularly worthy of notice for skill and sobriety: neither is the grand desideratum to a landsman (roomy accommodation) to be forgotten. There are 107 sleeping berths, all of the most ample dimensions, a limited number of which are divided off into state apartments. The grand saloon, around which these state apartments are arranged, is a magnificent room, and unites extreme comfort with ornament; on either side of it tables are ranged with elegant seats of richly carved oak, uniform with the chase panelling and groined roof. The entire fittings are of the most costly description, and the cuisine is excellent and cheap. The range of the *Admiral's* deck is 220 feet, it is perfectly flush, and forms a beautiful and unbroken promenade. The *Admiral* is a vessel of the same class and under control of the same business management at Liverpool as the Halifax line of steamers, and the same system of speed, punctuality, and good order which has obtained an exalted reputation for the Atlantic steamers prevails here, and has met with equal success.—*Morning Herald.*

MISCELLANEA.

ELECTRO-MAGNETIC PRINTING.

On Monday, 2nd ult., the first public exhibition of Mr. Bains's electro-magnetic printing-machine took place in the Lecture-room of the Royal Polytechnic Institution.

The apparatus consists of a dial-plate, inscribed with the alphabet and numerals, with a revolving hand, worked by ordinary clock-work. On the other side of the room stood the important portion of the invention—that which furnished in type the communication to be sent forth from the dial-plate already described. Between these two machines a connexion (capable of being extended in practice to any length) by means of wire conductors, communicating with two electro-magnets placed on a frame, and connected with a cylinder covered with paper, upon which the type was to leave its impression—an horizontal wheel, in which types to correspond with the letters and figures on the dial were fixed. This wheel was ingeniously brought in contact with an inking roller, and these three portions of the machine were all brought into motion horizontally.

The party directing the communication stands at the dial-plate first described, and fixes a peg under the letter desired to be communicated. The index or revolving hand performs its rotation until its progress is arrested by coming in contact with the peg. A small trigger is then pulled, the galvanic power is then brought to bear by the aid of the communicating wires upon the two electro-magnets, with their machinery on the second frame, and the letter thus communicated is printed upon the paper affixed to the cylinder.

The operations excited universal admiration, and the machine itself is well worthy the attention of the curious, for though at present it may fail as a speedy means of communicating information in print, still by the adoption of a code of signals (by which one letter or character might be construed to denote a sentence or describe a subject) the invention might be made extremely valuable in the times in which we live.

Electro-magnetic Exhibition.—A very interesting exhibition has been lately opened at No. 8, St. Andrew Square, Edinburgh. It consists of several working models of different machines, such as a turning-lathe, a printing-machine, a saw-mill, and a locomotive carriage, driven by the power of electro-magnetism. The inventor of these models is Mr. Robert Davidson, an ingenious mechanic from Aberdeen, who has been engaged upon them for the last four years, and who has succeeded in effecting several improvements in the application of electro-magnetism, which promise to be of great practical value. He is the first, we understand, who has employed the electro-magnetic power in producing motion, by simply suspending the magnetism without a change of poles. The mode employed by Jacobi, Davenport, and Storrar, consisted in keeping the repulsive power (which is equal to a third only of the attractive power) in operation during the one half of the time, and the attractive power during the other half. Mr. Davidson's discovery consists in a simple and extremely ingenious method of communicating and cutting off alternately the galvanic current to and from a pair of electro-magnets that always act attractively, so as to exert a constant moving force upon the machine which is put in action. It has received the approbation of numerous scientific gentlemen, who consider that Mr. Davidson has succeeded in showing the perfect applicability of magnetism as a motive power to engines of every description. It would no doubt be desirable, however, to see experiments tried on a larger scale; which Mr. Davidson, we understand, is anxious to do, but is deterred by the want of funds.—*Scotsman.*

Travelling by Electro-magnetic Power.—We are informed that a distance of 57 miles has been travelled on the common road, in a Bath chair, by electro-magnetic power, in one hour and a half; and further, that the applier comes over daily from St. Alban's to the Bank of England in the said chair in half an hour at an expense of sixpence. The model of an electro-magnetic engine, which has been exhibiting at the Adelaide Gallery for some time, is an instance of ingenious mechanic arrangement, whereby contact is broken and renewed, the poles reversed, &c.; and from its performances gave great promise of practical powers on a larger scale. The battery employed is the nitric acid, or Grove's battery. Of the invention that has done the great feat, and established the successful application of this wonderful agent, we know little more than its success. We hear that the increase of power is due to the discovery of a new combination of elements; that this is the secret of the moving power; and that the battery is to be the subject of a a patent.—*Literary Gazette.*

Edinburgh and Glasgow Railway.—It is gratifying to observe the incessant exertions which are making everywhere on the line in the vicinity of this city to get this national undertaking completed. The magnificent entrance to our great tunnel is drawing to a conclusion, while the booking and other offices are all but finished. The landing and departing platforms are now getting very handsome sheds, with elegant cast iron supports set up; and the ground is clearing out for laying the permanent rails. Yesterday Mr. John Craig, the mineralogist, made a survey of the tunnel, in furtherance of the objects of the British Association, and proceeded right through it, in company with the very polite and spirited contractor, Mr. Marshall. Amongst many other geological specimens got in the journey, we saw perfect masses of the *Nucula Tumida, Producta Scotia, Producta Martinnii, Bellerophon Urii,* and *Apiocrinites*, imbedded in a shale, above a two feet limestone, with many other interesting remains of a period long before the creation of man.—*Glasgow Constitutional,* August 4.

London and Brighton Railway.—The Brighton terminus is now completed externally. All the works are on a magnificent scale; and the passengers' sheds and station vie with any works of a similar kind in the kingdom. The station is even larger than that at the London terminus of the Birmingham Railway in Euston-square; and the edifice forms a pleasing and prominent object from various parts of the town.—*Brighton Gazette.*

Bristol and Glocester Railway.—The works on this line are proceeding rapidly in the neighbourhood of Wickwar, where 600 additional labourers have been put on this week.—*Glocestershire Chronicle.*

Cheltenham and Great Western Union Railway.—Contracts have been taken, and in some instances the works have been commenced, for carrying on this line from its present terminus at Cirencester towards Stroud and Gloucester. —*Cheltenham Looker-on.*

Paris and Rouen Railway.—This great work is proceeding rapidly, under the superintendence of Mr. Locke; and we understand that thirty-five miles of the Paris end of the line will be opened early in the spring of next year.

Railroad from Berlin to Hamburgh on the right bank of the Elbe.—The *Hamburgh Gazette*, under date Berlin, the 24th ult., announces that a commencement had been made in this affair. The provisional committee was appointed definitively, with power to adopt resolutions. This enterprise was calculated to consolidate the interests of so many people, that the most perfect accordance was necessary. The number of subscribers amounted to 5,000.

Railway Filters.—For some time a number of men have been employed in the erection of filters on the top of the terminus of the Greenwich Railway, for the purpose of supplying the engines with pure water, it having been discovered that the water that has been used has occasioned considerable injury and wear to the machinery. There are also similar filters erected at the New Cross station, on the Croydon line.

A Cast-Iron Light-house.—The necessity for a lighthouse to facilitate the navigation of the windward passage by the Morant point, in the island of Jamaica, so as to enable vessels to avoid the Morant Cays, a dangerous reef of rocks, 25 miles southward of that point, having been long felt by the authorities of the island, they have determined upon the erection of a tower and lights for that object, upon the recommendation and under the direction of their consulting engineer, Mr. Alexander Gordon; and it may now be seen in a very advanced state of forwardness, from the road at Pimlico, erecting on the works of Charles Robinson, proprietor of the long-known establishment of Bramah and Sons. It forms a most conspicuous and imposing object as it rears its head above the surrounding buildings; and when completed to its full height, 100 feet, will doubtless attract much notice from its novelty. The diameter of the base is 18½ feet, tapering gradually to 11 feet under the cap, which supports the lantern containing the lights and reflectors, which, with the actuating apparatus for revolving the lights, are constructing by Deville, of the Strand.

The Dry Rot.—Government have recently ordered the opening of the fungus pits in Woolwich dockyards, which had been closed in August, 1836, for the purpose of testing the virtues of Sir W. Burnett's process for rendering wood, cordage, and all descriptions of woollen free from the effects, of dry rot. The result, it would appear from the reports of the officers deputed by the Admiralty to superintend the experiments, is in every way successful, the prepared wood being as clear and sound when it came out as when first deposited. —*Inventors' Advocate.*

Thames Tunnel.—The shaft of the Thames Tunnel on the Wapping side of the river, in which the circular staircase is to be formed for foot passengers, has now almost entirely disappeared, and not more than five feet of it appears above the ground. A month ago it was on a level with the tops of the adjoining houses, and its gradual sinking as the earth below is excavated has excited the surprise of the inhabitants. In depth it is 60 feet, and it will be raised 15 feet higher, and again sunk. Since the engineer of the Tunnel, Sir Isambard Brunel, and three other gentlemen, passed under the driftway connecting the shaft with the Tunnel, many others have passed from one shore to the other by the same means. The completion of this stupendous work is close at hand.

Asphalte.—For some time past the Seyssel Asphalte Company's men have been actively engaged on the New Junction line of the Greenwich Railway, in covering the arches, which when completed will extend over a space of 400,000 feet.

New Steamers.—On the 21st instant a fine steam vessel was launched from the building yard of W. Pitcher, at Northfleet. She is for the Sicilian Government, and named the "Maria Teresa," her tonnage is about 300, and the collective power of her engine will be 120 horses, manufactured by Messrs. Boulton, Watt & Co. of Soho. A second vessel for the same government is in considerable progress, of smaller dimension to carry two 50-horse engines, from the same establishment.

A Miniature Steamer called the "Fire Fly," has been astonishing the frequenters of the Thames by its rapid evolutions on the river, she is a moderate sized boat propelled by Ericsson's propeller fitted in the stern and driven by two oscillating engines, set *horizontally*, and at right angles the crank shaft. The diameter of the cylinder is only 3 inches, and 6-inch stroke, making 180 to 200 strokes per minute, worked with high pressure steam of 50 to 60 lb. on the square inch, generated by a very compact locomotive boiler. The engines and boiler were entirely constructed by Mr. Warriner, formerly a pupil of Messrs. Braithwaite, Milner and Co., the engines possess several improvements worth introducing in larger engines, particularly the method adopted of conveying the steam into the cylinders instead of through the gudgeons, upon which the cylinders oscillate. She steams about 8 to 9 miles per hour through the water, and has run with the tide from Blackwall to Westminster Bridge in 50 minutes.

Captain Ericsson is now in New York, and engaged by the American Government to construct two engines of 1,000 horse power collectively for a large sea-going vessel to be propelled by the Captain's propellers.

Galvano-plastic Casts.—A letter from Munich informs us that the celebrated Bavarian sculptor Stigelmayer has brought to such a pitch of perfection his galvano-plastic process, that its effects would be deemed fabulous were they not publicly exhibited in the Museum of the Society of Arts. In the space of two or three hours colossal statues in plaster are covered with a coat of copper, which takes with the greatest accuracy the most minute and delicate touches, giving the whole all the appearance and solidity of the finest casts in bronze. M. Stigelmayer has also applied his process to the smallest objects, as flowers, plants, and even insects, bringing them out with such accuracy, that they seem to have been executed by the hands of the most skilful artists.

Highest Chimney in the World.—The highest chimney in the world is at the soda ash manufactory of James Muspratt, Esq., near Liverpool. It is the enormous height of 406 feet above the ground, 45 feet diameter inside at the base, 9 feet ditto at the top, and contains nearly 4,000,000 of bricks.—*Daily paper.*

LIST OF NEW PATENTS.

GRANTED IN ENGLAND FROM 28TH JULY, TO 27TH AUGUST, 1841.

Six Months allowed for Enrolment.

JOSEPH RATCLIFFE, of Birmingham, manufacturer, for "*certain improvements in the construction and manufacture of hinges for hanging and closing doors.*" (A communication.)—Sealed August 4.

OWEN WILLIAMS, of Basing Lane, London, engineer, for "*improvements in propelling vessels.*"—August 4.

JOHN LEE, of Newcastle-upon-Tyne, manufacturing chemist, for "*improvements in the manufacture of chlorine.*"—August 4.

JAMES WARREN, of Montague Terrace, Mile End Road, for "*an improved machine for making screws.*"—August 4.

STOFFORD THOMAS JONES, Tavistock-place, Russell Square, gentleman, for "*certain improvements in machinery for propelling by steam or other power.*"—August 4.

WILLIAM CRAIG, engineer, ROBERT JARVIE, rope-maker, and JAMES JARVIE, rope-maker, all of Glasgow, in the kingdom of Scotland, for "*certain improvements in machinery for preparing and spinning hemp, flax, wool, and other fibrous materials.*"—August 11.

SAMUEL BROWN, of Gravel-lane, Southwark, engineer, for "*improvements in the manufacture of metallic casks or vessels, and in tinning or zincing metal for such and other purposes.*"—August 11.

JOHN SEAWARD, and SAMUEL SEAWARD, of the Canal Iron Works, Poplar, engineers, for "*certain impeovements in steam engines.*"—August 13.

WILLIAM HALE, engineer, and EDWARD DELL, merchant, both of Woolwich, for "*improvements in cases and Magazines for gun-powder.*"—August 13.

JOHN HARVIG, of the Strand, gentleman, and FELIX MOREAU, of Holywell-street, Millbank, sculptor, for "*a new and improved mode or process of cutting or working cork for various purposes.*"—August 21.

JOHN HARVIG, of the Strand, gentleman, and FELIX MOREAU of Holywell-street, Millbank, sculptor, for "*a new or improved process or processes for sculpturing, moulding, engraving, and polishing stone, metals, and other substances.*"—August 21.

JOHN THOMAS CARR, of the town and county of Newcastle-upon-Tyne, for "*improvements in steam engines.*" (A communication.)—August 21.

GEORGE HICKES, of Manchester, agent, for "*an improved machine for cleaning or freeing wool, and other fibrous materials, or furs and other extraneous substances.*"—August 21.

CHARLES DE BERGUE, of Broad-street, London, merchant, for "*improvements in axletrees and axletree boxes.*" (A communication.)—August 21.

FREDERICK DE MOLEYNS, of Cheltenham, gentleman, for "*certain improvements in the production or development of electricity, and the application of electricity for the obtainment of illumination and motion.*"—August 21.

WILLIAM WALKER JENKINS, of Gred, in the county of Worcester, manufacturer, for "*certain improvements in machines for the making of pins, and sticking the same into paper.*"—August 27.

EDMUND MOREWOOD, of Highgate, Middlesex, gentleman, for "*an improved mode of preserving iron and other metals from oxidation or rust.*" (A communication.)—August 27.

MILES BERRY, of Chancery-lane, civil engineer, for "*certain improvements in the means and apparatus for obtaining motive power, and rendering more effective the use of known agents of motion.*" (A communication.)—August 27.

SAMUEL HARDMAN, of Farnworth, near Lancaster, spindle and fly-maker, for "*certain improvements in machinery or apparatus for roving slubbing cotton and other fibrous substances.*"—August 27.

THOMAS CHAMBERS and FRANCIS MARK FRANKLIN, of Lawrence-lane, London, and CHARLES ROWLEY, of Birmingham, button manufacturer, for "*improvements in the manufacture of buttons and fastenings for wearing apparel.*"—August 27.

TO CORRESPONDENTS.

"G. Coe."—*On Reversing Engines; an accident occurred, as we were going to press, which damaged the engravings, we were therefore obliged to postpone the notice until next month.*

Severn Navigation.—*We have received a very valuable report by Mr. Fulljames, on the proposed improvements of the river, well deserving a perusal by all parties connected with this long contested "improvement."*

Mr. Brooks and Mr. Barrett.—*After a careful perusal of the communications from these two gentlemen, we have determined not to insert them, as we feel convinced that they will only lead to an endless altercation between both parties.*

We must request the favour of our correspondents, who may favour us with articles which require engravings to illustrate them, to let the drawings be separate from the manuscript, and drawn on thin paper—good tracing paper is the best, and if possible to draw them so that they shall come within the width of a column (3½ inches), or the width of a page (7 inches.)

Communications are requested to be addressed to "The Editor of the Civil Engineer, and Architect's Journal," *No. 11, Parliament Street, Westminster.*

Books for Review must be sent early in the month, communications on or before the 20th (if with drawings, earlier), and advertisements on or before the 25th instant.

Vols. I, II, and III, may be had, bound in cloth, price £1 each Volume

ERATTA.

Page 319, *col.* 1, 18 *lines from the bottom, for* "quantity," *read* "pressure."

Page 319, *col.* 2, 23 *lines from the top, for* "our atmosphere," *read* "four atmospheres."

HISTORY OF DECORATIVE SCULPTURE IN FRANCE.

(Concluded from page 259.)

When the kings of the first race founded the French kingdom, they built churches, some of which are mentioned by Gregory of Tours (B. 2 § 14, 15, &c.), but which have all unfortunately been destroyed. Some remains of these primitive edifices are still however to be seen in marble capitals used in the churches rebuilt after the Norman ravages. Thus at Montmartre there are capitals of white marble, the style of which calls to mind degenerate antique forms, and which can only be assigned to the first ages of Christianity; this is evident from the Greek cross still to be seen on the volutes of one of them, the irregular management of the foliage, the inferior execution, and the sharp forms which made their appearance with Christianity, and did not leave until the Revival. These are features belonging to a period of art very nearly approaching the Lower Empire, but Christian notwithstanding as the emblems plainly show. At Jouarre, a place famous for its abbey, is still to be seen a subterranean chapel at the end of the cemetery, having, like the church of Montmartre, several capitals of white marble, which in the singular form of their leaves, and in the variety of their composition, since there are no two alike, show more of the classic character of antiquity, and on the contrary present all those which are proper to the first centuries of Christianity. The church of St. Denis has on several capitals *fleurons*, like those of Jouarre, and which might have formed part of the church of Dagobert. To the same period a Greek cross, found some years ago behind the apsis of the present church, appears to belong. The ruins of the Abbey of St. Medard, at Soissons, have among them a marble capital, in which may be recognized the degenerated traces of ancient art, and seeming to belong to some of the edifices of the kings of Soissons, who were buried at St. Medard.

Between this first period of modern civilization and the eleventh century, monuments are wanting to enable us to follow up step by step the history of the subject before us, a deficiency which must no doubt be attributed to the numerous invasions, which took place during the Carlovingian reigns. When the reign of the Capets commenced Robert the Pious rebuilt the churches, and art took a new direction, of which there is now abundant evidence. The church of St. Germain des Prés, at Paris, for instance, notwithstanding many details attributable to the barbarism of the age, has some fine parts, particularly around the choir. There, the capitals, composed of large leaves, contain chimerical animals, contributing to the effect of the composition, and the great variety which prevails is good proof of the rich and fertile imaginations of the medieval artists. At this period the leaves of the acanthus and the volutes, with other elements of ancient ornament, still formed part of decoration, but their general forms were entirely modified. The historical capitals of the nave of St. Germain are also of the eleventh century, and are not less interesting than those of the choir. (See Figs. 1 and 2.)

During this period of art, the capitals form two very distinct classes, 1st, of those in which, in imitation of the Pagans, Christian artists only imitated foliage as the basis of decoration; 2nd, capitals enriched with human or animal figures, and of which the origin is also to be found among the ancients. The first are evidently a consequence of the capitals of the first period of our era, of which we have mentioned that there are examples at Montmartre, St. Denis and Jouarre. In the eleventh century they exhibit an imitation more or less exact of the Corinthian column. The ornaments of the astragal of the capital in the church of St. Spire at Corbeil, and of Esnay at Lyons, are composed of water leaves, imitated from the antique, and executed badly enough. In the cloister of Moissac they are replaced by Byzantine rosettes. The foliage of this period presents acute forms, removing the artist from the study of nature, a direction which was given to art by the Orientals in the time of Justinian, and afterwards adopted in the west. Above the astragal is the capital, differing from that of the ancients as it takes every imaginable geometric figure, the details of the Corinthian foliage gradually disappearing and giving place to original compositions, sometimes not without harmony and taste. The subjoined capital from the church of St. Germain des Prés is an instance of this.

During the whole period, included between the last Carlovingians and the 13th century, the principal elements of ornamental sculpture are an imitation, more or less good, of the acanthus, their leaves edged with pearls, palms, scrolls, and other exotic types.

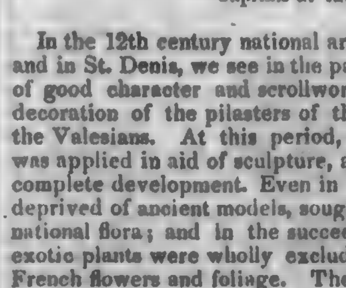
The second class of medieval capitals is distinguished from the first by heads of men and animals, chimeras, and sea or land monsters, mixed up with acute foliage imitated from the oriental flora, and which are afterwards succeeded by religious, historical, or symbolical subjects covering the whole surface of the capital to the exclusion of other

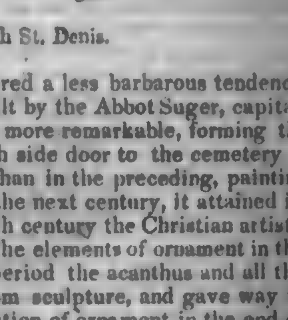
Fig. 1. Fig. 2.

Capitals at the Church St. Germain des Pres.

ornament. This second system, like the first, owes its origin to antiquity. The Etruscans often mixed up the heads of men with foliage in their capitals;* the Romans introduced persons on foot, of which a fine example is to be found in St. Lawrence without the Walls. Without leaving France, ancient examples are to be found of this mode of decoration, as at Vienne in Dauphiny, where on a beautiful Corinthian marble capital of large proportion, are four heads of Pagan divinities. The Museum of the same city contains a fragment seemingly rather later, and in which are also figures and animals in the midst of foliage. A Medusa's head is in the middle, two serpents intertwined form the volutes, which rest on large acanthus leaves. The church of St. Germain des Prés shows the whole progress of the system, some of the capitals being covered with historical and religious subjects. (Vide Fig. 2.) The royal vault in the subterranean church of St. Denis, is decorated with purely historical capitals, representing kings of France, bishops removing relics, &c. (Vide Fig. 3.)

Fig. 3. Fig. 4.





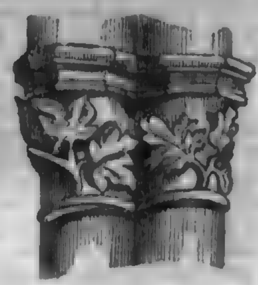
Capitals at the Church St. Denis.

In the 12th century national art acquired a less barbarous tendency, and in St. Denis, we see in the parts built by the Abbot Suger, capitals of good character and scrollwork still more remarkable, forming the decoration of the pilasters of the north side door to the cemetery of the Valesians. At this period, more than in the preceding, painting was applied in aid of sculpture, and in the next century, it attained its complete development. Even in the 12th century the Christian artists, deprived of ancient models, sought for the elements of ornament in the national flora; and in the succeeding period the acanthus and all the exotic plants were wholly excluded from sculpture, and gave way to French flowers and foliage. The execution of ornament in the end of the 12th and 13th centuries is very good, for the sculptor, being perfectly acquainted with the forms he was to imitate, produced broad and noble compositions, in a style which, although severe, was completely in harmony with the buildings. In the 13th century Peter of Montereau, architect to St. Louis, one of the most skilful artists of his time, gave new vigour to the art of decoration; he introduced in the chapel of Our Lady in the church of St. Germain des Prés, and the Sainte Chapelle of the Palais, ornaments of remarkable precision and taste. Notre Dame, which has some parts of the same date, shows in the great capitals, supporting the columns of the nave, and in the details of the doors, how much the art of the sculptor was advanced.

* See an example in the British Museum.—Edit.

Fig. 5.

Fig 6.



Capitals at the St. Chapelle, Paris.

Figs. 7 and 8.

Ornaments from the Church Notre Dame, Paris.

The capitals of the Hotel de Dieu at Paris, of the Abbey of Poissy, of the front of St. Julian the Poor, &c., were so many masterpieces of the luxuriant imagination of the decorators of the 13th century. Among the examples of this period may also be classed the beautiful ironwork of the gates of Notre Dame; it is composed of scrollwork in the best taste and of the finest execution. The date of it is not decided; but it evidently belongs to the 13th century, agreeing in style with the ornament of the rest of the building. In the gate in the middle of the grand front the skilful artist has intermingled birds, winged dragons and foliage, with a statue of St. Marcel in the midst. This beautiful piece of ironwork is unique in Europe, and well deserving of the attention of artists on account of the elegant forms which have been given to the iron.

The ornament of the 14th century was of a character almost as high as that of the preceding, but the forms had already become less simple and less true, the capitals were divided into stages of foliage, the as-

Fig. 9.

tragals assumed the obtuse angles of the polygon, and the foliage rolled upon itself, gives an appearance of confusion which destroys the general effect. The fleurons which decorate the finials and crocketings are formed of sharp and divided leaves, as thistles and holly, from which there results less severity of appearance in buildings of this age than in those of the foregoing.

In the 15th century great license prevailed in national art; the sculptors gave themselves up to the most vagabond inventions, representing climbing plants of a light form and divided foliage. The vine, thistle, and endive were the most frequent models adopted in buildings of this period, and the use denoted the approach of a revolution. The execution is free, and shows great facility, which they abused, and often to such a degree that their productions are mere

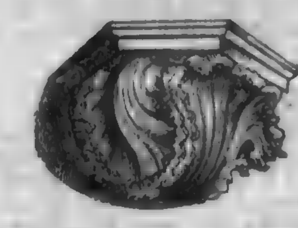
Fig. 10.

From the Church at St. Gervais.

Fig. 11.

Crocket for the Cathedral of Clermont.

Fig. 12.



From the Chapel of the "Hotel de Cluny."

sketches, touched up with taste. While however we refuse to the decorator of this period the gravity, which characterizes the labours of the two preceding periods, we are obliged to acknowledge that they produced works, remarkable for the luxuriance and variety of their composition, and the effect of the boldness of their undercutting. Towards the end of this century the Revival of ancient art began to take root in the midst of the productions of national medieval art, and again were oriental productions mixed with those of the indigenous Flora. The reign of Louis 12th has left us many monuments of this period of transition, among which the façade of the Chateau de Gaillon, at the Palace of the Fine Arts, deserves to be particularized, as showing the union of the two styles.

Under Francis the 1st, the revolution in art became complete, the ancient style imitated with more or less perfection, sometimes witnessed the introduction of Gothic forms, but always without any disturbing effect. The details of the tomb of Louis the 12th, and the capitals of the Chateau de Madrid, are well enough known to require only to be alluded to. It was under Henry the 2nd, that the Revival arrived at its height. The Louvre, the Chateaux of Anet and Ecouen

Fig. 13.

Bracket for a Lamp, from the Chateau de Gaillon.

and the Tomb of Francis the 1st are monuments perfect in the details of their ornamental sculpture, in which they may contend with classic antiquity, the Revival however was never a servile imitator of the Greek and the Romans. This epoch is particularly remarkable for the composition of capitals and arabesques.

From the reign of Henry the 4th, the Revival begins to lose part of its charm, ornaments became heavy, too numerous, and neglected in their execution, showing how much art had declined.

Under Louis the 13th and 14th, the direction given to ornamental sculpture was in some degree stationary, but at the end of that age, during the Regency and the whole reign of Louis 15th, the decline was rapidly going on. In fact, the corruption of form was such that no epoch in the history of the art has ever produced any thing similar. In the details of the architecture of this period, we witness the complete absence of the observation of nature, which hitherto had always been looked up to as a guide.

Under Louis 16th, it was seen how little this capricious style was adapted to the decoration of severe edifices, and a return to the antique was begun by the architects Soufflot and Servandoni. There were still to be seen however remains of the influence of that bad taste which gave way to the revolution of 1789, and the serious study of the antique which has been pursued in the 19th century.

THE ETCHING CLUB.

This association has been formed by twelve artists (eleven painters and one sculptor), composed of the following gentlemen, whose names will at once be recognized as amongst the most rising of the day:—Redgrave, A.R.A; Webster, A.R.A.; Knight, A.R.A.; Cope, Taylor, Creswick, Horsley, Townsend, Stonhouse, Bell, and F. Stone, with the view of reviving the older excellence of the art of etching, and of conferring upon the popular literature of the country, especially poetry, a more pleasing, original, and artist-like mode of illustration. The first work that they have sent forth, consists of a series of eighty-two illustrations of Goldsmith's exquisite poem, "The Deserted Village. These illustrations, in whatever way regarded, whether for originality of conception, beauty of composition, truth and delicacy of feeling, or correctness of delineation, are worthy of the highest praise. We regret, however, to perceive that the club have adopted the barbarous practice of destroying the plates after taking a certain number of impressions, which, in these days, is quite inexcusable.

FOOT BRIDGE OVER THE RIVER WHITADDER.

SIR—In the number of your Journal for July last, there is a description of a proposed new construction for railway viaducts on the tension bar principle, in which the writer refers to the foot bridge over the river Whitadder, in Berwickshire, on the property of George Turnbull, Esq., of Abbey St. Bathans, as an instance in which the principle he proposes has been applied to bridges. The principle however as adopted at Abbey St. Bathans foot bridge is not carried so far as in the proposed railway viaduct, and as it is simple in its construction, and is found to answer the purpose well, you may consider the accompanying sketch of its details not unworthy of a place in your Journal.

In 1821 Mr. Robert Stevenson of Edinburgh,* designed a bridge for the river Almond, in Edinburghshire, in which the principle of supporting the roadway by iron bars passing underneath was first adopted. This plan however differs from that now in use at Abbey St. Bathans' bridge and elsewhere, as the chains for supporting the roadway are fixed in the abutments, whereas at Abbey St. Bathans the roadway beams themselves are made to resist the strain. Mr. Smith of Deanston, has erected a foot bridge of this kind 108 feet span near Doune.

I am not aware where and by whom the plan of fixing the tension bars to the extremities of the roadway beams was first adopted, but the principle has now come into pretty general use. A beam may in this way be rendered perfectly rigid, and even forced into a slightly arched form, and from the lightness and compactness of the whole it possesses many advantages over the other methods in which the same thing is accomplished.

In 1833 a bridge was erected on the tension bar principle over an arm of the Lake of Geneva. It has 13 openings of 55 feet span, and is 25 feet broad. The same plan has been adopted for two foot bridges of 138 and 81 feet span respectively erected several years since over the river Ness, near Inverness, and also for a bridge over the river Whitadder, in Berwickshire, at Hutton Mill, designed by Mr. Jardine, of Edinburgh, which consists of three openings 60 feet span. Mr. Smith has also applied tension rods very successfully for supporting the floors of the Deanston cotton works, where they have been in use for many years. These, so far as I am aware, are the only instances in which this principle has been adopted.

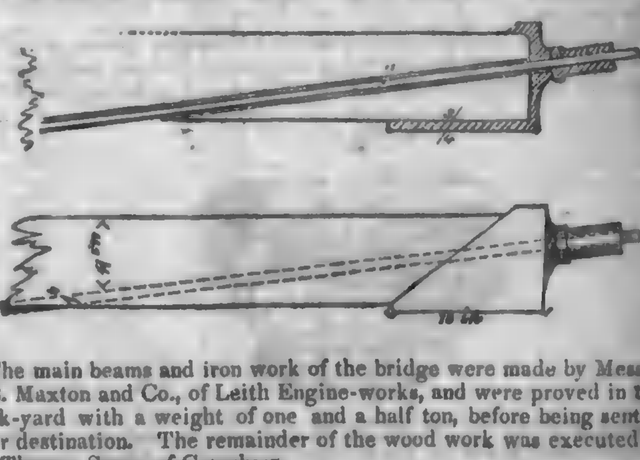
* See Edinburgh Philosophical Journal for October, 1821, and Drewry on Suspension Bridges, page 30.

The Whitadder is subject to heavy floods, especially in the winter season, which interrupts the intercourse between the opposite banks, and as there is no bridge within many miles of Abbey St. Bathans, the want of some means of communication was long felt to be a great inconvenience, and several attempts had been made to build a foot bridge by which the water might be crossed at all times, without having recourse to the inconvenient and often dangerous alternatives of a ferry-boat or a ford: but the heavy floods and ice during the winter destroyed the erections by carrying away the piers.

Messrs. R. Stevenson and Sons, of Edinburgh, being applied to for a design of a bridge, recommended one on the tension bar principle, from its simplicity of construction and the moderate cost at which it might be executed.

The bridge was commenced at the beginning of last summer, and finished in the course of six months. Its total length is 160 feet, and its breadth 4 feet. The planking is 16 feet above the water, which rises 11 feet on the piers during floods, and although the bridge was originally intended for foot passengers only, horses have been occasionally taken across it. It consists, as will be seen from the sketch fig. 1, of two main openings of 60 feet span, and a smaller one of 24 feet span. The beams are supported upon piers of coursed Graywacke rubble. The two in the centre measure 10 feet × 7 feet at the base, and batter to 6 ft. 6 in. × 4 feet at the top. The one which is most exposed to the water is founded upon rock, at the depth of 4 feet under the bed of the river, and the other is founded upon a platform of timber laid on gravel. A causeway of river stones is laid round the base of the piers to protect their foundations from the run of the water. The beams for supporting the roadway planking were made of four pieces of timber for the convenience of getting them readily conveyed across the hills; they measure 11 inches × 6 inches, and are formed of planks of red pine 11 inches × 8 inches. Two of them are 37 feet long, and two 27 feet, so that when put together the scarphs which are 2 ft. 6 in. long occur at different places and exactly over the uprights. The planks are firmly fixed together by means of oaken treenails 3 feet apart, driven right through and wedged at both ends. The ends of the main beams fit into cast iron shoes, as shown in figs. 5 and 6, and the tension rods which go under the beams, and support them by means of the uprights, pass through auger holes in the centre of the beams, and are secured by means of screw nuts 6 inches long to the back part of the iron shoes, as shown in figs. 5 and 6. The diameter of the tension rods is one inch. The screws are used in order to tighten up the rods, which is done until the beams are quite rigid.

Figs. 5 & 6.—Section and side view of the Ends of the Beams.



The main beams and iron work of the bridge were made by Messrs. J. B. Maxton and Co., of Leith Engine-works, and were proved in the work-yard with a weight of one and a half ton, before being sent to their destination. The remainder of the wood work was executed by Mr. Thomas Swan, of Cranshaw.

The entire cost of the bridge was as follows:

	£	s.	d.
Masonwork	£101	7	5
Main beams and iron work	50	0	0
Planking and railing	78	6	0
Forming approaches, &c.	8	5	0
	£237	18	5

I remain, your obedient servant,

JOHN R. WILSON.

47, *Melville Street, Edinburgh,*
27th August, 1841.

FOOT BRIDGE OVER THE RIVER WHITADDER AT ABBEY ST. BATHANS, BERWICKSHIRE.

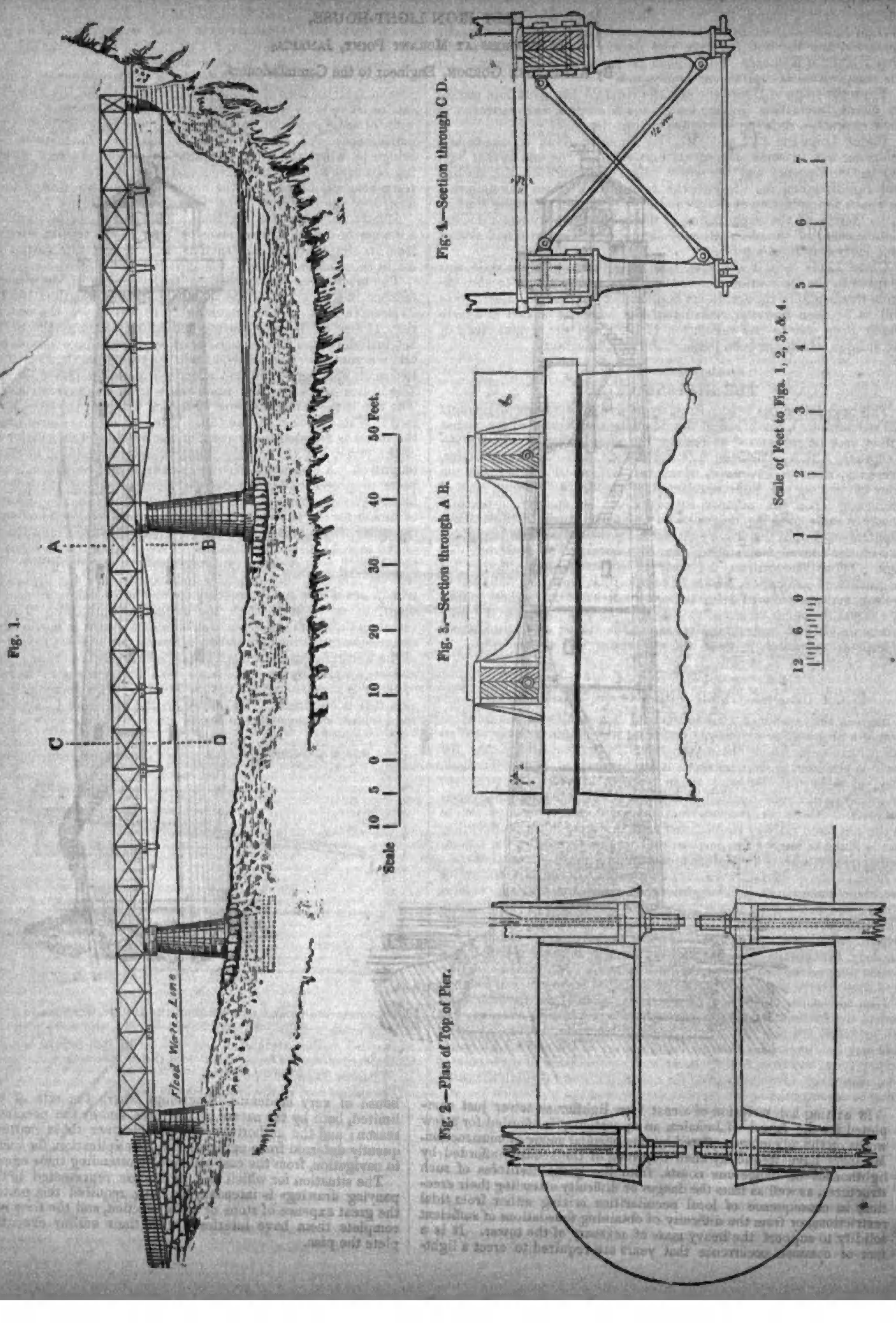


Fig. 1.

Fig. 2.—Plan of Top of Pier.

Fig. 3.—Section through A B.

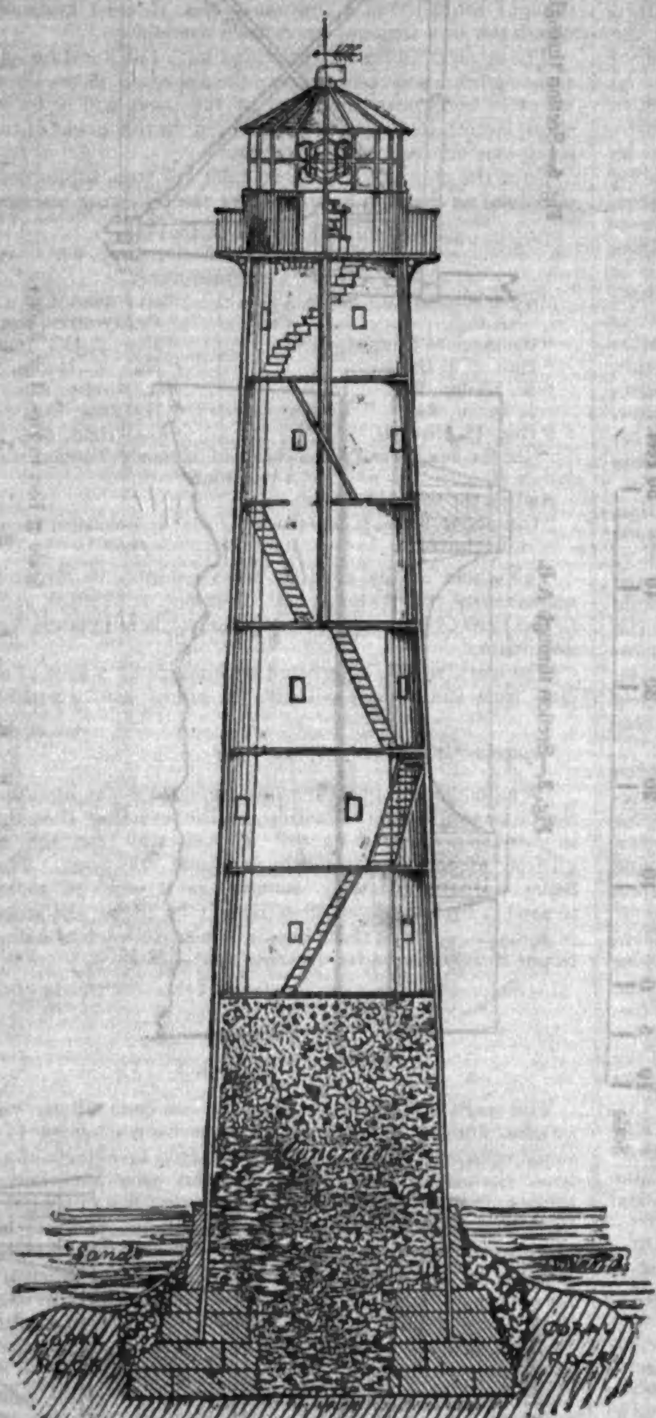
Fig. 4.—Section through C D.

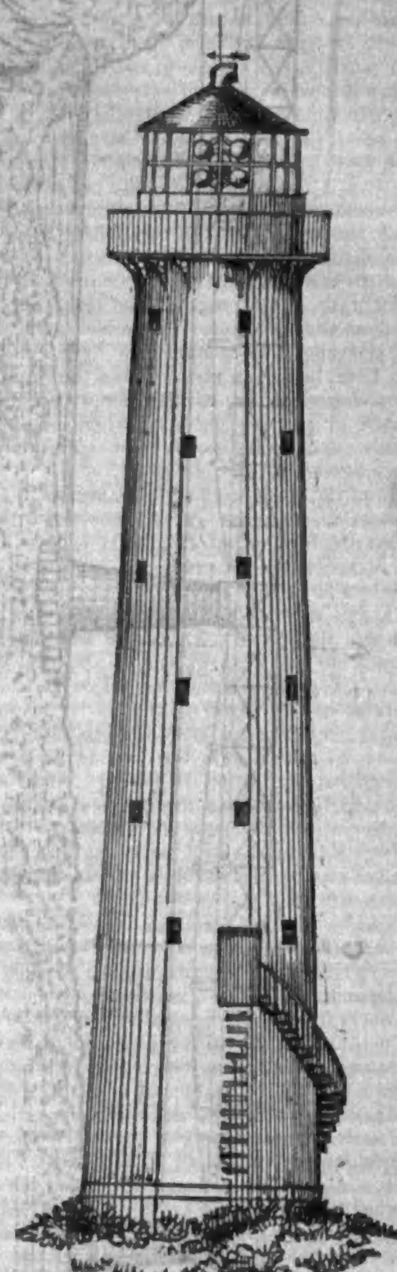
Scale of Feet to Figs. 1, 2, 3, & 4.

CAST IRON LIGHT-HOUSE,

In progress at Morant Point, Jamaica,

By Alexander Gordon, Engineer to the Commissioners.





In writing a description of a cast iron lighthouse tower just completed for the Island of Jamaica, an opportunity is afforded for a few words on the advantages offered by this peculiar mode of construction. Mariners have frequently been deprived of the security afforded by lighthouses on dangerous coasts, from the great costliness of such structures, as well as from the danger or difficulty attending their erection, in consequence of local peculiarities arising either from tidal restrictions, or from the difficulty of obtaining foundations of sufficient solidity to support the heavy mass of masonry of the tower. It is a fact of common occurrence that years are required to erect a lighthouse of very moderate dimensions where the rate of working is limited, both by the nature of the tides, and by the peculiarity of the season; and the authorities who preside over these matters are frequently deterred from entertaining the application, for such facilities to navigation, from the cost and trouble attending their execution.

The situation for which the lighthouse represented in the accompanying drawings is intended, has long required this protection, but the great expence of stone or brick erection, and the time required to complete them have interfered with their earlier execution to com plete the plan.

Mr. Alexander Gordon, the engineer to the Commissioners appointed to carry the plan into effect, is the designer of this building, and who recommended the adoption of cast iron, in consequence of the suggestions some years ago of Captain Sir Samuel Browne, and the subsequent erection of a small light tower on Gravesend Pier, by Mr. Clarke.

The advantages which iron, when not in contact with sea water, possesses over stone or other materials, is, that upon a given base a much larger internal capacity for dwellings and stories can be obtained with equal stability. The nature of the material admitting of the plates being cast in large surfaces, there are fewer joints, and consequently greater solidity. A system of bonding the plates may also be adopted, which will insure the perfect combination of every part, so as to form one entire mass, and by the facility which such a plan offers for uniting the parts, the best form for strength and stability can be obtained. The time required for the construction of such a building in iron being less than that required for the preparation of one of stone, would in many instances influence its adoption, and from the comparatively small bulk and weight of the component parts of the structure, much greater facilities are afforded for transporting and erecting it at its destination. It is a fact worthy of remark that in less than three months from the date of the contract, the lighthouse in question was cast and erected on the contractor's premises, and it is the intention of Mr. Gordon, the engineer, to have the light exhibited in Jamaica, on January 1st, 1842, being six months from the date of its commencement. This is a degree of expedition commensurate with the extraordinary despatch of the present day, when all operations however great and difficult, seem to advance with a celerity which a few years back would have been deemed chimerical.

The expences of the construction, the transmission to its destination, and its final erection, will not exceed one-third the cost of a stone building of equal dimensions and capabilities, and in localities where the materials are not naturally produced, but have to be transported from a distance in a fit state of immediate erection, the expence would considerably exceed this ratio. Another prominent feature in the construction of iron lighthouses, &c. is the security from electric influence, the material itself being one of the best conductors of the electric fluid, and if proper means be taken to transfer the electric fluid from the base of the tower to the sea by means of copper conductors, no danger need be apprehended from its effects.

The lighthouse in question is the first of its kind that has been practically carried out, and from its having to withstand the destructive hurricanes, which, as well as the frequent earthquakes that occur in the West Indies, it will afford a good example for future practice. The form has been selected as well for strength as for symmetry; and the arrangement of the lantern and light apparatus reflects the greatest credit on the manufacturer, Mr. Deville.

The tower is to be founded on a coral rock, a little above the level of the sea, the face of which rock is about 10 feet beneath the surface of the sand, and which will be excavated to receive the base of the tower, resting on and cased with granite, to prevent the natural filtration of the sea water from acting upon the iron. The course of granite upon which the base of the tower rests, is grooved to receive the flange of the lower plates, from which the lightning conductors are continued to the sea. The diameter of the tower shaft is 18 ft. 6 in. at its base, diminishing to 11 feet under the cap; it is formed of nine tiers of plates, each 10 feet in height, varying from 1 to ½ inch thickness. The circumference is formed of 11 plates at the base, and nine at the top, they are cast with a flange all round the inner edges, and when put together these flanges form the joints which are fastened together with nut and screw bolts, and caulked with iron cement. The cap consists of 10 radiating plates which form the floor of the light room, and secured to the tower upon 20 pierced brackets, being finished by a light iron railing. The lower portion, namely 27 feet, is filled up with masonry and concrete, weighing about 300 tons, and so connected with the rock itself that it forms a solid core of resistance; the remaining portion of the building is divided into rooms which are to be appropriated as store rooms and berths for the attendants in the lighthouse.

The light room consists of cast iron plates 5 feet high, on which are fixed the metal sash bars for receiving the plate glass, these terminating in a point are covered with a copper roof, from which rises a short lightning rod, treble gilt at the point, to attract the electric current.

The light is of the revolving kind, consisting of 15 Argand lamps and reflectors, 5 in each side of an equilateral triangle, and so placed as to constitute a continuous light, but with periodical flashes.

In order to preserve as low a temperature as the nature of the circumstances and climate will permit, the iron shell is to be lined with a non-conducting material, such as slate or wood, leaving an annular interstice, through which a constant ventilation will be effected, and by which the excessive heat will be carried off, or which it will doubtless be assisted by the evaporation of the sea spray which may accidentally be cast upon it, as it will be placed within 60 yards of the ordinary water level.

In order to preserve the two lower tiers from oxydation, they have been coated with coal tar, and Mr. Gordon intends to set them in the granite with a bituminous cement. The only bracing which has been thought requisite is a few cross ties at each horizontal joint, over which the iron tongued wood floors are laid.

The several rooms are provided with five apertures fitted with oak sashes glazed with plate glass; the approach to the doorway which is about 10 feet above the level of the sand, will be by means of stone steps, ladder irons are also provided in the event of the stone steps being carried away by a hurricane.

Over the entrance is a large tablet of iron, supported by two small ones, and on them, in bas relief, are the following inscriptions:—

"Erected A. D. 1842,
"Under the act 3 Victoria, cap. 66.
"Commissioners.

"Vice-Admiral Sir Charles Adam, K.C.B.	"E. Jordan, Esq.
"Commodore Douglas, R.N.	"P. Lawrence, Esq.
"Hon. S. J. Dallas.	"Hon. T. M'Cormack.
"W. Hyslop, Esq.	"Hon. E. Panton, Speaker.
"J. Taylor, Esq.	"A. Barclay, Esq.
"Hon. H. Mitchell.	"H. Leslie, Esq.
	"G. Wright, Esq.

"On the designs and specification of Alexander Gordon, civil engineer, London."

And on the side supporters:—

"Captain St. John, R.A., Island Engineer."	"C. Robinson, Engineer, London, *fecit*."

The whole of the castings were executed by Mr. Robinson at his manufactory, (late Bramah and Robinson), at Pimlico, and put together in the yard of the manufactory prior to their removal for its intended destination.

The work will be re-erected in Jamaica by means of a derrick and crab from the inside, without the aid of any external scaffolding.

Arch. R. Renton.

September 22, 1841.

[We understand that the whole expence of the lighthouse, including the passage over the Atlantic, and the erecting it on the promontory in Jamaica, will not exceed £7000, and that the entire weight of iron of the whole fabric is about 100 tons. The masonry is being prepared in this country, as it will be more economical to send it from England than it will be to get the stone and work it in Jamaica. Three mechanics are also to be sent out with the work to put it together on its destined spot.—Editor.]

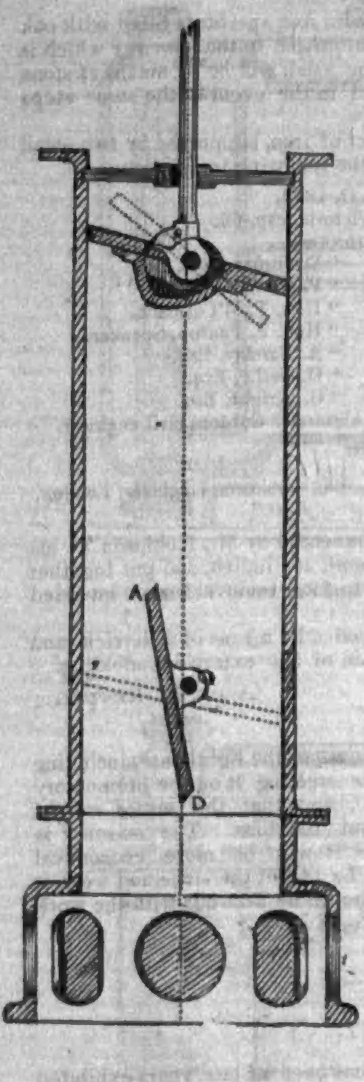
TURKEY.

The spirit of improvement which has been of late years exhibited by the Turkish government has not been confined to political and social reforms, but has also been directed to objects of a practical nature. In aid of these efforts frequent calls have been made on the talents of our engineers, and some very fine machinery indeed has been sent out to Constantinople. Much of this has been on a very large scale, and we may enumerate saw mills, musket machinery, and gun-boring machinery. The machinery supplied by Messrs. Maudslays for boring brass guns, said to be the finest and most extensive of any in the world, has given great satisfaction. The same firm have lately finished an order for mint machinery, also on a large scale, which has excited great commendation from the completeness of its design, and the beauty of its execution. It consists of two 16 horse power high pressure engines, two pair of large rollers, and two pair of smaller rollers, six cutting out presses, two double draw benches, four coining presses with pneumatic apparatus, and a die sinking press, with two double acting milling machines, ingot moulds, &c. To those who admire this class of machinery, as who does not, the examination of this minting apparatus was highly interesting, uniting as it did all the recent improvements which have been adopted in our mint. The Turkish dockyard it must be farther remembered, is directed by an Anglo-American, and is in a very efficient state, and the public at Constantinople have recently been turning their attention towards steam navigation, so that we may look forward for a new market for our machinery in the Turkish empire. To the engineering and mining interests the progress of this increasing branch of our commerce is of great importance.

IMPROVED CONSTRUCTION OF PISTONS AND VALVES, FOR RETAINING OR DISCHARGING LIQUIDS, &c.

Patented by Messrs. G. H. Palmer and Charles Perkins.

Fig. 1. Fig. 2.



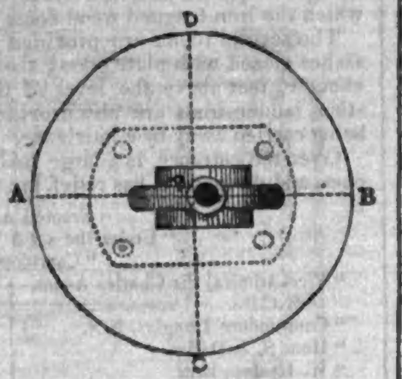


Fig. 3.

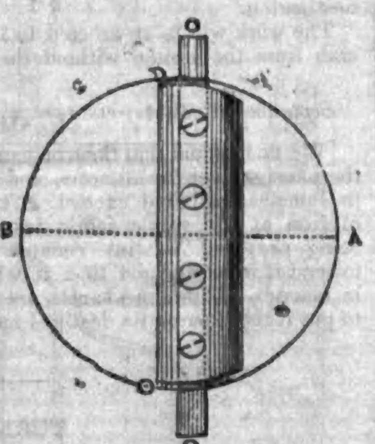


Fig. 5. Fig. 4.

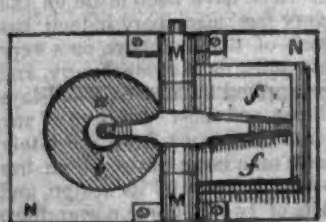


Fig. 1, is a plan of the piston, a section of which is shown by fig. 3. A B the major, C D the minor diameter; the joint (by which the pump rod is secured), is in the centre of the true line of the major diameter A B, but neither in the centre of the pump or piston, being removed therefrom more or less as the diameter of the pump, the altitude of the column of water lifted, and other circumstances may require. The whole area of the piston is therefore divided into two unequal areas.

Fig. 2, is a plan of the lower valve, which is fixed in the barrel by means of the axle O, the eccentricity of which is regulated upon the same principle as that of the joint in the upper valve or piston.

Fig. 3, shows the relative position of the piston and valve during the upward or effective stroke. The dotted lines show the position of the valves in the downward or return stroke.

Figs. 4 and 5, are a plan and section of a patent double balancing valve, an application of the same principle as adapted for safety, or any valves connected with steam engines or air pumps, also to lock gates or sluices, and generally as a simple and effective mode of retaining or discharging liquids, gases and steam. The two valves being of unequal, but the inner of the greater area, and the pressure upon both, being in the same line of direction, it is evident that the power to open or shut them may be determined at pleasure by regulating the difference between the two areas, *a b* is the larger, and *f f* the valve of smaller area, each of which are connected with, and works upon, the axle M M, supported by carriages on the valve bed N N. The valves *a b* and *f f*, receive simultaneous action by means of the curved lever or tail piece X.

The patentees recommend the adoption of the patent elliptic self-adjusting balancing pistons in all pumps for whatever purposes intended, as the most simple, durable and effective of any arrangement now before the public. Simple, as is evident from the diagrams and description herewith. Durable, because the process of raising water from any depth is performed by two metallic discs, not liable to derangement, and free from most casualties of climate, circumstance, or wear. Effective, first, because a very superior water way is obtained, (there are no valves to clog or gag, no resting place for any extraneous matter to impede the duty of the pump, whether it be sand or rubbish). Secondly, it will remove the evil arising from concussion in pumps of large diameter; and thirdly, in consequence of the decreased amount of friction, the service of a man in pumping is increased in the ratio of nearly 3 to 1, as the following statement will demonstrate.

The patentees have two 10 inch pumps, the levers 6 to 1, the stroke 8 inches, the column of water 5 feet; both pumps were made by Messrs. Bramah and Robinson, in their best manner; alike in all respects, except that one is fitted with the usual packed bucket and butterfly valves, the other with the patent piston and valve. In an experiment recently made with weights over a pulley, it required the exertion of a force equivalent to 461 lb. to raise and deliver the water, (about 2 gallons), and return the bucket with the packed pump, and only 196 lb. to do the same work with the patent pump; making the labour to work the two pumps in the ratio of 461 to 196 = 23 to 10.

Another experiment was made for the patentees by Mr. Beale, of Greenwich, showing similar advantages in the diminution of friction, and consequently an increase power. The following is the result of this experiment.

A vessel of a capacity equal to 314·16 gallons = 3141 lb. was filled by pumping 140 strokes in 4½ minutes, which was at the rate of 31 strokes per minute, and 2·244 gallons per stroke. The working barrel of the pump was intended to be 10″, but was said to have been turned to 10¼ inches nearly.

If the diameter was 10, then the delivery by computation in 140 strokes of 8″ = - - - - -	318 gallons.
If the diameter was 10¼, then the delivery = - -	330
The actual delivery was by computation of the receiving vessel = - - - - - - -	314

The average lift during this time was about six feet.

In a second experiment the water in the well was kept at an average height which, with pipes added to the exit pipe, made the total lift 15 feet 4 inches.

Under these circumstances weights were applied to the end of the lever, and it took 98 lb. × 6 the leverage to raise the column of water.

Now 98 × 6 = - - - - - - - - - -	588 lb.
The actual weight of a column of water 10¼″ diameter and 15 feet 4 inches in height, is - - - - -	550 lb.
Leaving for friction in the up stroke only - - -	38 lb.

As there was no friction in the down stroke or return of the piston, it results that 38 lb. was the total amount of friction out of 588 lb. (exerted), being only 6·46 per cent. or $\frac{1}{16}$ part.

The velocity of the water may be taken at 20 feet per minute.

In a third experiment, to produce a *maximum* effect, two men made 41 strokes in one minute, lifting the water 15 feet 4 inches, and delivering as per first experiment 2·244 gallons, or 22·44 lb. per stroke = to 14107·28 lb. raised one foot high in one minute by two men, or 7053·64 lb. raised one foot high in one minute by *one* man.

Artificial Ice.—The projectors of the artificial ice plan have found a site in the New Road, opposite Lord's cricket ground. We have seen the composition, which seems to succeed, and the plan is approved by the Skating Club.